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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

Radiological Health Data and Reports

With this issue, *Radiological Health Data and Reports* makes its appearance, not as a successor to *Radiological Health Data,* but rather as a more accurate expression of the function served by the publication since it was first issued in 1960.

Its revised format provides for the separation of articles dealing with data received through regularly reporting surveillance networks and programs from reports in which data are reviewed, analyzed, and interpreted. Also, the text material in the "Data" sections is considerably reduced as compared with the narratives that previously accompanied corresponding articles, the current short introductory texts being intended solely to provide orientation to the data. Definitive descriptive papers are included as references for the reader who requires more detail on individual networks and programs.

Where it becomes necessary or advisable to include extensive interpretive discussions or methodology, such articles will qualify as reports, and will appear in the "Reports" section. One other change is that all reports will be found grouped in a single section, rather than dispersed among the different "Data" sections as in the past.

It should be emphasized that this publication's established purposes and responsibilities—the collation, analysis, and interpretation of data on environmental radiation levels—remain unchanged. These responsibilities were delegated to the Department of Health, Education, and Welfare by Presidential directive in 1959, and have not been altered.

It is hoped the reader who has a general interest in the field as well as the investigator who employs its data will find that the new format of *Radiological Health Data and Reports* will contribute to economy in reading time while still retaining useful detail in the "Data" sections.

The Editors

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RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 7, Number 1 January 1966

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data and Reports, a monthly publication of the Public Health Service, includes data and reports provided to the Division of Radiological Health by Federal agencies, State health departments, and foreign governmental agencies. Pertinent original data and interpretive manuscripts are invited from investigators. These are subject to review by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Defense
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Radiological Health Data and Reports is published under the direction of

Dr. Donald R. Chadwick, Chief, and
James G. Terrill, Deputy Chief
Division of Radiological Health

by the Radiation Surveillance Center, DRH
Donald L. Snow, Chief

Address correspondence to the Managing Editor, Radiation Surveillance Center, Division of Radiological Health, Public Health Service, Washington, D.C. 20201.

For further information on any subject reported in this issue, readers are referred to the contributors indicated in article headings.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

Reports

THE APPEARANCE OF IODINE-131 AND BARIUM-LANTHANUM-140 IN FALLOUT DUE TO THE SECOND CHINESE NUCLEAR TEST

James E. Johnson, Daniel W. Wilson, and Gerald M. Ward [1]

SYNOPSIS—Fresh fission product debris of the May 14, 1965 Chinese nuclear device test was detected at Fort Collins on May 25. Levels of iodine–131 in milk reached a peak of 130 pCi/liter on June 5. Barium–lanthanum–140 was not detected in milk samples. The expected spring increase of cesium–137 was observed in forage and milk samples.

Evidence of the second mainland Chinese nuclear test of May 14, 1965, was detected at Fort Collins, Colorado, on May 25, 1965. On this date the short-lived fission products ^{141}Ce, ^{103}Ru, ^{95}Zr-Nb, and ^{140}Ba-La were found in precipitation and on forage samples which were being collected routinely in a study of fallout deposition at Colorado State University. These nuclides were first identified in a gamma-ray spectrum of an alfalfa sample harvested on May 25 and counted one week later (*1*). The radionuclides ^{125}Sb, ^{137}Cs, and ^{54}Mn from older nuclear debris were completely masked in the gamma-ray spectrum by the photopeaks of the shorter-lived nuclides in the fresh fallout. The normal spring increase in ^{144}Ce, ^{125}Sb, ^{106}Ru, ^{137}Cs, and ^{54}Mn was expected at approximately that time as it had been observed here for the previous three years of fallout monitoring. By means of chemical separations of fission products in forage (*2*), an increase in cesium–137 content was shown from May 20 to June 4. The increase in cesium–137 was probably almost all due to the normal spring injection of older debris and not to the Chinese test.

Iodine–131 was detected on May 27 in the milk from a nine-cow herd fed greencut alfalfa harvested daily. Iodine–131 levels in milk from May 25 to June 26 are given in figure 1. Pasture forage levels of barium-lanthanum–140 are shown in the same figure. By comparison, the iodine–131 concentrations in milk from our pasture herd during July 1962 reached a peak around 4,000 pCi/liter.

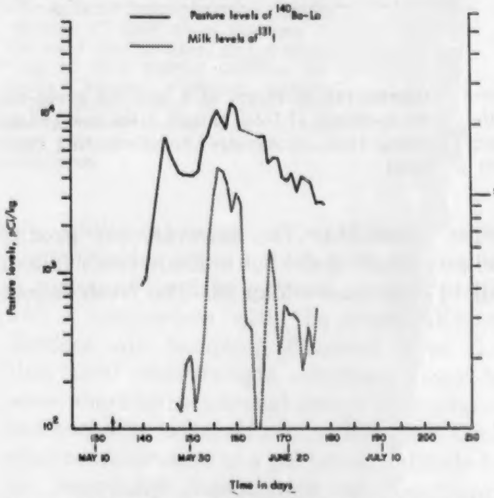

Figure 1. Pasture levels of barium–lanthanum–140 and milk levels of iodine–131 at Fort Collins, Colorado, from the second Chinese nuclear device test (arrow indicates date of detonation)

All environmental samples were counted by gamma-ray spectrometry with an 8- by 4-inch sodium iodide (thallium) crystal under conditions of low background. Barium-lanthanum–140 was not detected in 5.5-liter milk samples counted 2 hours on the large crystal. It was, however, observed in an *in-vivo* gamma-ray spectrum of a cow from the herd. The count was made by a 9- by 4-inch sodium iodide crystal over the rump of the cow in our whole-body counter. Figure 2 shows the gamma-ray spectra of the cow and of the feces sample containing fresh Chinese test debris.

Krey and Rosa (*3*) indicate that the leading edge of the debris cloud from the second Chinese test should have arrived over Fort

[1] Dr. Johnson is a radiation biologist, Mr. Wilson a chemist, and Dr. Ward, Professor of Animal Science, Colorado State University, Fort Collins, Colorado.

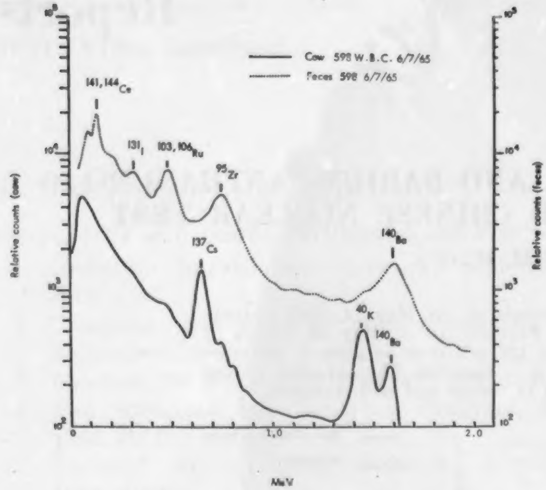

Figure 2. Gamma-ray spectrum of a cow fed green-cut alfalfa and spectrum of feces sample from cow (whole body counting time, 25 minutes; feces counting time, 180 minutes)

Collins about May 18; however, our ground level air sampling did not indicate fresh fallout until 10 days later—May 28. The fresh fallout was detected in rain that fell May 23–25, which indicates that the upper tropospheric activity was being excluded from ground-level air. Between May 23 and June 30, Fort Collins received 6.0 inches of rain, more than one-half the average annual precipitation. This was a major factor in the high total deposition; but due to the frequency of heavy rains, the efficiency of deposition (*i.e.*, the deposition coefficient) is not expected to be high (*4*).

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GAMMA ACTIVITY IN SURFACE AIR—80TH MERIDIAN NETWORK JANUARY-MARCH 1965

Philip W. Krey [1]

SYNOPSIS—Monthly measurements of gamma activity during the first quarter of 1965 are presented for stations in both hemispheres. Latitude profiles of the results for the first 3 months of 1965 show maxima at midlatitudes for both hemispheres, a low near the equator, and a minimum at Chacaltaya, Boliva. Comparison of first-quarter profiles for 1964 and 1965 indicates generally similar shapes, although gamma activity decreased sharply in the Northern Hemisphere in early 1965. Average concentrations for the hemispheres show spring maxima and evidence of the mainland Chinese nuclear test of October 16, 1964, as well as different trends in the two hemispheres.

Gamma activity in surface air has been reported monthly by the U.S. Atomic Energy Commission Health and Safety Laboratory (HASL) since January 1963 as part of a continuation of the 80th Meridian Program initiated by the U.S. Naval Research Laboratory.

The core of the sampling network (figure 1) is a line of 14 stations in the longitude band from 66° W to 80° W, which extends from Thule, Greenland (76° 36′N), to Punta Arenas, Chile (53° 08′S). The U.S. Weather Bureau maintains a site at the Amundsen-Scott South Pole Station, and the samples from this location are also included in the HASL program. The high-altitude station at Mauna Loa, Hawaii (19° 28′N, 155° 36′W), was installed to serve as a comparator and Northern Hemisphere counterpart of the high-altitude station at Chacaltaya, Bolivia (16° 21′S, 68° 07′W), in the Southern Hemisphere.

Figure 1 shows that the stations in the Northern Hemisphere generally lie along the east coast of the continent, while in the Southern Hemisphere, the stations line the west coast. Since the prevailing wind is from west to east, there was concern that there might be some coastal effect. To explore this possibility, six additional sites within the continental United States were activated in August 1963. A review of the data generated by this program and a comparison with the United Kingdom Surface Air Sampling Program have shown that local meteorologic conditions may have some short-term seasonal effects on surface air radioactivity concentrations, but that the annual concentration in a particular latitude band is essentially independent of longitude or coastal effects (*1, 2*).

Sampling and analytical procedures

About 1,400 cubic meters of surface air per day are drawn through an 8-inch (20.32 cm) diameter polystyrene base filter (Microsorban). The filters are changed on the 1st, 8th, 15th, and 22nd of each month. During periods of nuclear testing, the spectrum of each sample is measured at HASL with an 8- x 4-inch NaI (thallium) crystal, approximately 2 weeks after collection. During quiescent periods when fresh fission product debris is absent in surface air, the weekly samples are compressed and assayed as a monthly composite. The gamma ray activity in the range between 100 keV and 3.0 MeV is integrated and reported as the total gamma activity. Subsequently, the weekly samples are combined into a monthly composite and analyzed radiochemically for fission products, induced radionuclides, and specific tracers.

[1] Mr. Krey is a staff member of the Environmental Studies Division, Health and Safety Laboratory, U.S. Atomic Energy Commission, New York, N.Y. 10014.

Figure 1. HASL 80th Meridian Network sampling stations

Activity latitude profiles

The total gamma activity concentrations in monthly composited air filter samples for January, February, and March 1965 are given in table 1. The data are corrected to the midpoint of the sampling month via the measured decay curve of several samples collected in both the Northern and Southern Hemispheres. The activity latitude profiles for each month (plot of activity concentration versus latitude) are presented in figures 2, 3, and 4. The averages of the New York and Westwood stations are plotted as a single value on each of the figures. The curves are drawn through the points in the 65° W to 89° W longitude band. The points in the 90° W to 125° W longitude band sometimes deviate from the curves, but they do not significantly alter the profiles.[2] The profile for the average gamma concentrations during the first 3 months of 1965 is compared in figure 5 to the average profile for the first quarter of 1964.

Daily air filter samples were collected at New York from January 21 through February 1 in an effort to detect debris from the U.S.S.R. underground test on January 15. Fresh fission product debris as evidenced by the presence of barium–140 was not discernible in the spectra of any daily or weekly samples. It was concluded that no significant amounts of material from the U.S.S.R. test reached the HASL Surface Air Sampling Network. A similar conclusion was made for the Kiwi destruct test of January 12 (*3*).

[2] A complete discussion of longitudinal effects was given in a summary of 1964 results, see July 1965 *Radiological Health Data*, p. 346.

Table 1. Gamma activity in surface air January–March 1965

Sampling site	Latitude	Gamma activity (Photons/min·m³)		
		January 1965	February 1965	March 1965
Northern Hemisphere:				
Thule, Greenland	76°36′	0.184	0.132	0.287
Moosonee, Canada	51°15′	0.0983	0.132	0.183
Seattle, Wash	47°36′	0.0684	0.147	0.342
Appleton, Wis	44°15′	0.133	0.188	0.295
Westwood, N. J	41°00′	0.143	0.202	0.202
New York, N. Y	40°48′	0.163	0.223	0.227
Washington, D. C	38°58′	0.140	0.209	0.177
Palo Alto, Calif	37°30′	0.0954	0.227	0.311
Midwest City, Okla	35°25′	0.155	0.195	0.245
Chattanooga, Tenn	35°03′	0.163	0.198	0.204
Miami, Fla	25°49′	0.165	0.198	0.224
Mauna Loa, Hawaii	19°28′	0.128	0.310	0.209
San Juan, P. R	18°26′	0.111	0.133	0.186
Miraflores, C. Z	9°00′	0.0748	0.0844	0.0290
Southern Hemisphere:				
Guayaquil, Ecuador	2°10′	0.0301	0.0236	0.0160
Lima, Peru	12°06′	0.0650	0.0523	0.102
Chacaltaya, Bolivia	16°21′	0.0165	0.0171	0.0258
Antofagasta, Chile	23°37′	0.0604	0.0549	0.0484
Santiago, Chile	33°27′	0.0766	0.0624	0.0514
Puerto Montt, Chile	41°27′	0.0433	0.0495	0.0395
Punta Arenas, Chile	53°08′	0.0268	0.0371	0.0304
South Pole		0.0254		

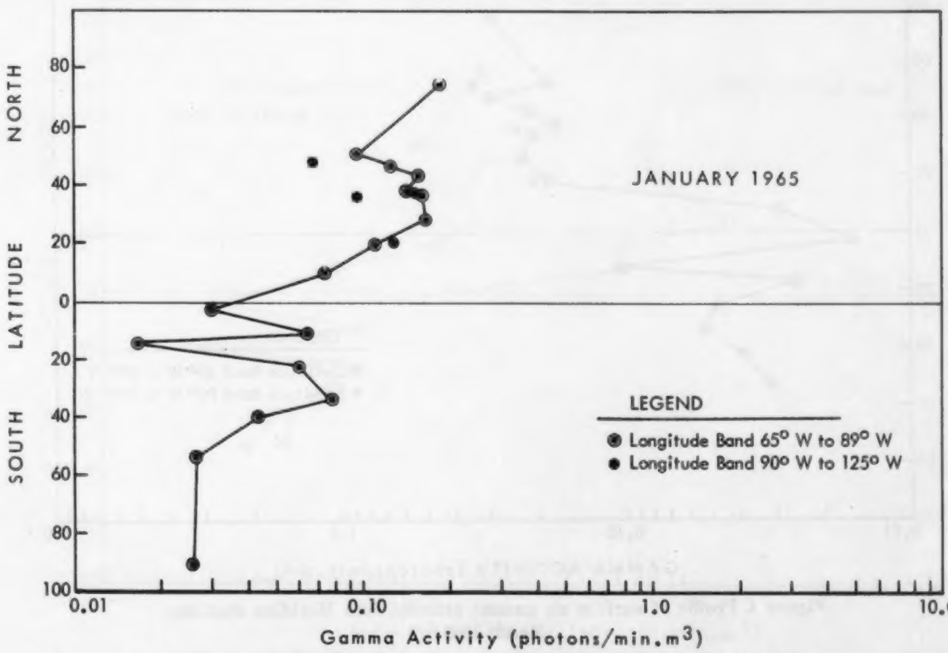

Figure 2. Profile of surface air gamma activity, 80th Meridian stations, January 1965

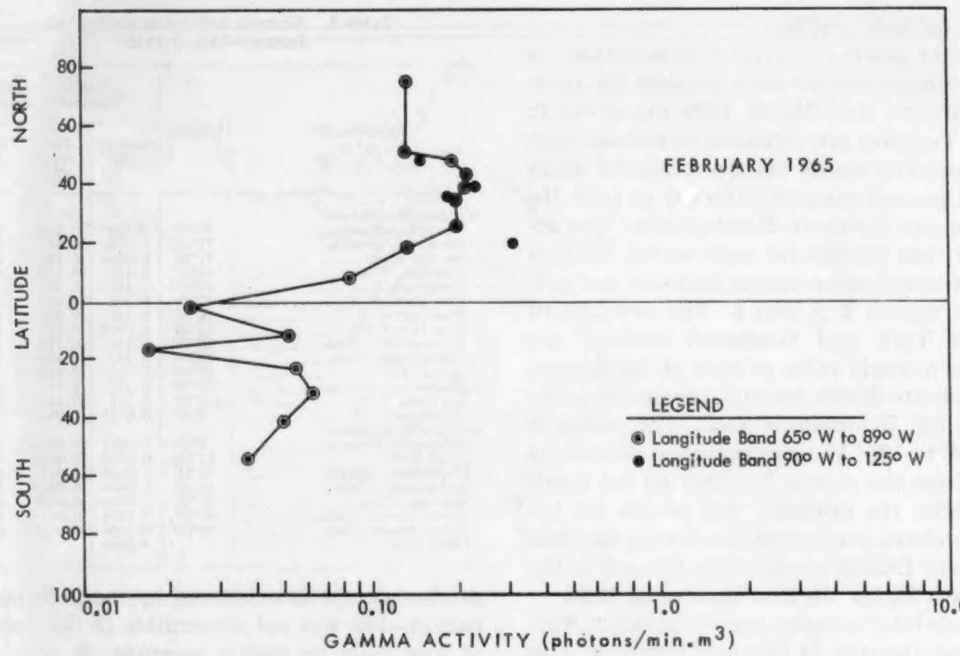

Figure 3. Profile of surface air gamma activity, 80th Meridian stations, February 1965

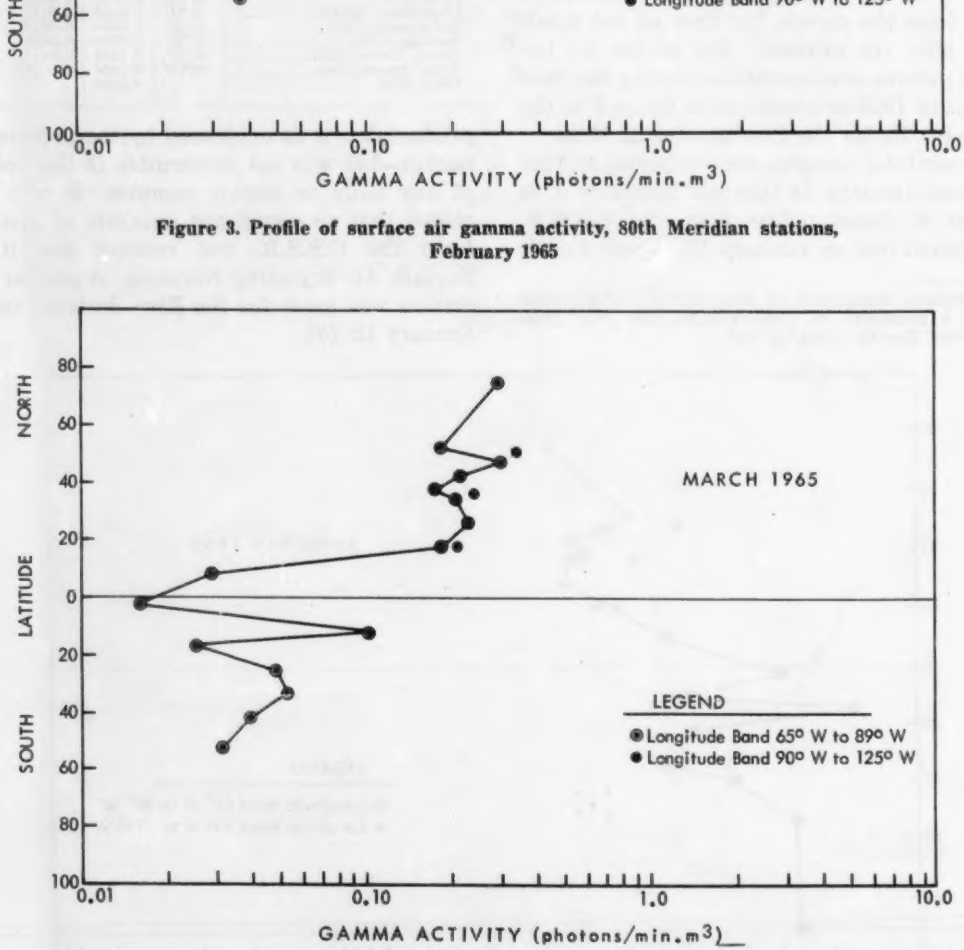

Figure 4. Profile of surface air gamma activity, 80th Meridian stations, March 1965

The profiles in figures 2 through 5 reflect a persistent pattern of maxima at midlatitudes in both hemispheres, a low near the Equator, and a minimum at Chacaltaya, Bolivia (16° 21′S). The profile in the Northern Hemisphere for the first quarter of 1965 (figure 5) is similar to the equivalent profile in 1964 but at one-fifth the concentration. The main difference between the two profiles is a less pronounced peak in the concentration at Miami, Florida (25°49′N), during 1965. In the Southern Hemisphere the two profiles are almost identical from 12° southward. The concentration at Guayaquil, Ecuador (2°10′S), in 1964 is about four times the concentration in 1965, even though the concentrations at the other stations in the Southern Hemisphere are almost equal. This may be the result of a slight tropospheric transequatorial exchange between hemispheres. Since the disparity in the activity concentrations between the hemispheres was much greater in early 1964, the effect of a slight transequatorial exchange would be more pronounced at that time than in the following year when the hemispheric concentrations were more nearly equal.

These distributions of activity with latitude are consistent with a model of the atmosphere illustrated in figure 6 (*4*). Much of the activity from the stratospheric reservoir is considered to be transferred through the tropopause gaps. The activity is then transported downward at midlatitudes by the strong and weak circulation cells in each hemisphere which would give rise to maximum activity concentrations in surface air in these areas. As the air is advected equatorward by the strong circulation cell, the activity is scavenged by precipitation and possibly impaction of the radioactive particles on the earth's surface without significant reinforcement from above. This mechanism would provide for low concentrations in equatorial regions. The minimum concentration of activity at Chacaltaya has been attributed to the high altitude of this station (*5–9*), although a similar behavior has not been observed at Mauna Loa.

Average hemispheric gamma concentrations

The average gamma activity concentrations for each month in the Northern and Southern Hemispheres weighted for the volume of surface air in each 10° latitude band are plotted in figure 7 from the beginning of the HASL Surface Air Sampling Program in January 1963. The mean concentration in each 10° latitude band was multiplied by the area of that

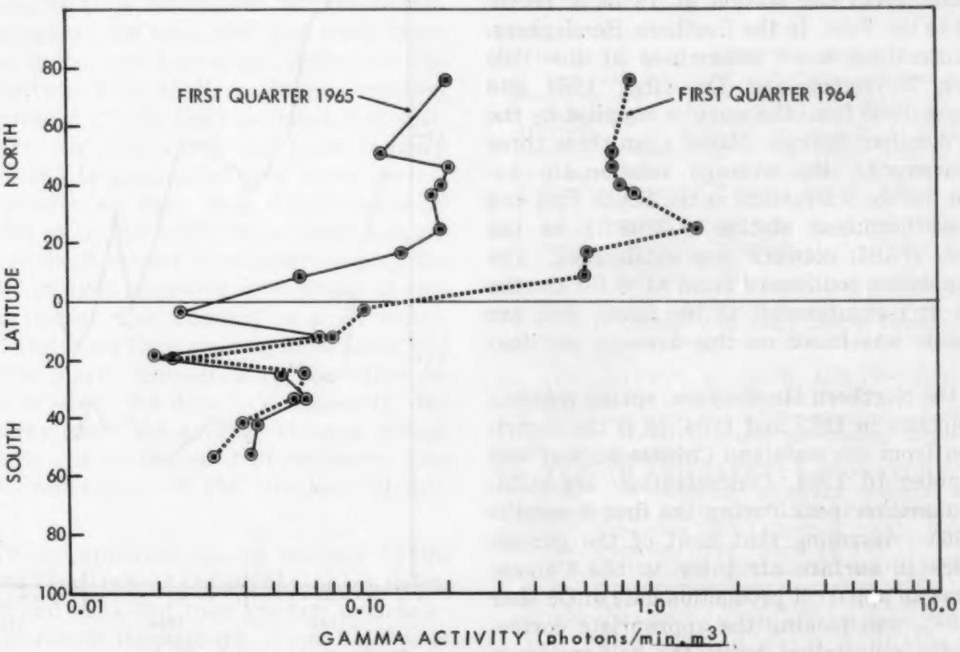

Figure 5. Profile of surface air gamma activity, 80th Meridian stations, first quarters of 1964 and 1965

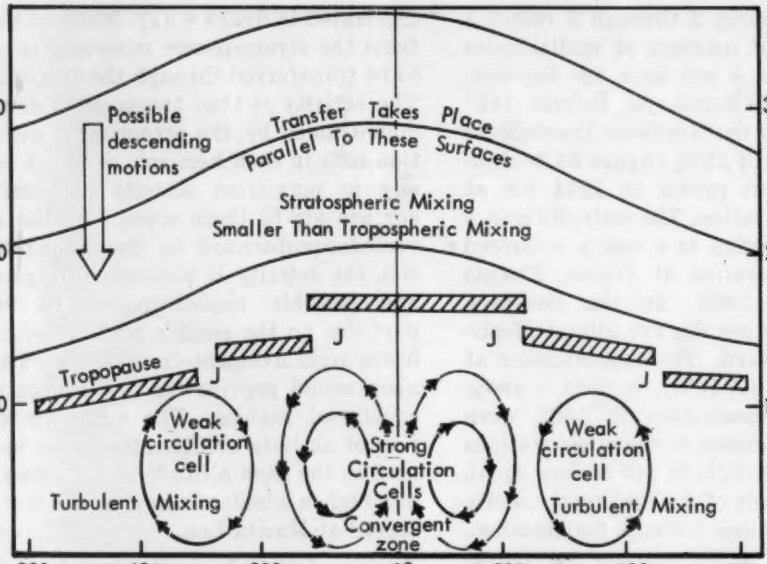

Figure 6. Schematic cross section of atmosphere ("J" locates typical jet stream positions)

10° band. The sum of these products from 0° to 90° was divided by the total area of the hemisphere to give the average hemispheric concentration for the month. In the Northern Hemisphere, the concentrations were assumed to be constant from the station at 76°36′N northward to the Pole. In the Southern Hemisphere, concentrations were determined at the Pole during November and December 1964 and January 1965 from the samples supplied by the U.S. Weather Bureau. Based upon these three measurements, the average relationship between the concentrations at the South Pole and the southernmost station (53°08′S) in the normal HASL network was established. The extrapolation southward from 53°S for months when no measurements at the South Pole are available was based on this average relationship.

In the Northern Hemisphere, spring maxima are obvious in 1963 and 1964, as is the contribution from the mainland Chinese nuclear test of October 16, 1964. Concentrations are building to another peak during the first 3 months of 1965. Assuming that most of the gamma activity in surface air prior to the Chinese test has an apparent production date of October 15, 1962, and making the appropriate corrections for radioactive decay, the half-residence time of debris in the Northern Hemisphere

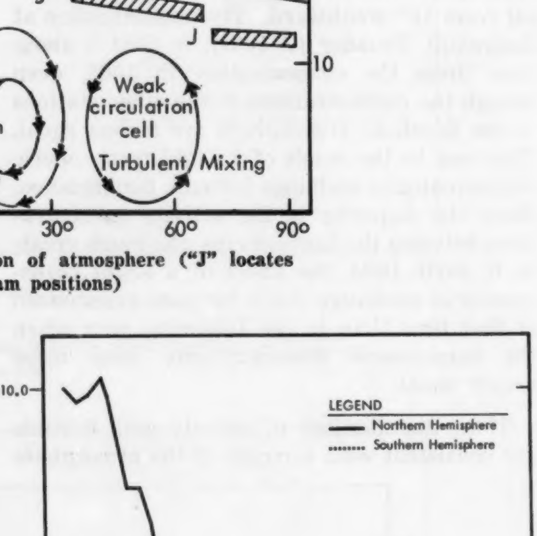

Figure 7. Average hemispheric gamma activity concentrations for 1963 through March 1965

troposphere from April to June 1963 and from July to September 1963 is 54 days. The activity concentrations remained the same during June and July of 1963. From May to September 1964, the half-residence time for the Northern Hemisphere troposphere was 57 days, which is in good agreement with the 1963 value. These calculations make the oversimplifying assumption that no significant amount of activity enters the troposphere from the stratosphere for the remainder of each year after the maximum in the spring peak is reached. Consequently, this value represents a maximum half-residence time for tropospheric debris. This estimate of the half-residence time is a factor of about two higher than previous calculations of 30 days, made during the nuclear test moratorium in 1959 (*10*).

In the Southern Hemisphere, the average troposphere concentrations shown in figure 7 decreased rapidly during the early part of 1963, perhaps as a result of the rainout of debris from the U.S. tests at Johnston Island during late 1962. Again, assuming an October 15, 1962, production date, and making decay corrections, the half-residence time for debris in the troposphere of the Southern Hemisphere from January to May 1963 is about 68 days. While this value is 25 percent greater than the half-residence time determined for the Northern Hemisphere for both 1963 and 1964, there is probably no real significant difference between the two. First of all, the decay correction which greatly affects the calculated half-residence time for debris collected from January to May 1963 is more dependent upon the assumed production date than debris collected late in the year. Secondly, the activity concentration in the Southern Hemisphere during the first half of 1963 appeared to decrease at two different rates. For January and February, the half-residence time appears to be about 110 days. For March through May, the value decreased to about 34 days. Consequently, the uncertainty about the average is large enough to include the estimated half-residence time for the troposphere of the Northern Hemisphere.

There are apparent spring maxima in the Southern Hemisphere during the latter halves of 1963 and 1964, but they are not as clear as in the Northern Hemisphere. From September 1963 to June 1964, the decrease in the average gamma activity concentration of surface air in the Southern Hemisphere is not greatly different from what might be expected from radioactive decay. The assumption that the spring maximum represents the only significant intrusion of activity into the troposphere each year may not apply to the Southern Hemisphere at that time. For example, it has been suggested in this report and earlier (*8*) that there is some transequatorial penetration into the troposphere of the Southern Hemisphere by debris from the troposphere of the Northern Hemisphere. Whatever the explanation, it is evident from figure 7 that there were meteorological parameters operative in the Southern Hemisphere after September 1963 which were not exhibited during the early part of 1963, or at any time in the Northern Hemisphere.

Continuing with the assumption that the apparent production date of most activity in surface air even for the Southern Hemisphere was October 15, 1962, one can compare the activity concentrations during any particular month from one year to the previous year by calculating an appropriate decay factor. These yearly decay factors decrease from 2.4 in October 1964 to 1.8 in March 1965. On this basis, figure 7 shows that the radioactive fallout in the Southern Hemisphere has been greater since September 1964 than it was during the corresponding period of the previous year.

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RADIOCARBON IN THE ENVIRONMENT

J. C. Drobinski, Jr.[1]

SYNOPSIS—Analyses of various samples collected since July 1962 indicate that radiocarbon levels in man and most of his foods have increased about 20 to 30 percent above 1950 levels. This compares to a carbon–14 increase in surface air on the order of 40 to 70 percent.

In July 1962 a research program was initiated at the Northeastern Radiological Health Laboratory by the Research Branch of the Division of Radiological Health to assay foods for carbon–14. It is known that large quantities of this radionuclide are produced when neutrons released in the explosion of nuclear devices are captured by nitrogen atoms (*1*). Man in general is reported to be 18 percent carbon; and DNA, for example, is 37 percent carbon. An increase of carbon–14 in man and his environment involves considerations related to both somatic and genetic effects (*2–7*). It is desirable, therefore, to measure existing levels of this nuclide for evaluation of its potential radiological health hazard. This paper reports specific activities of carbon–14 found in environmental samples. These data are limited in extent and permit only limited correlations between levels in different phases of the environment and in man.

Background

Carbon–14 is generally formed under oxidizing conditions, and therefore exists in the air mainly as carbon dioxide; it enters the photosynthesis process before it reaches animals and man through the food chain.

There is natural or normal carbon–14 produced by the cosmic ray bombardment of nitrogen in the upper atmosphere. A value commonly used for the year 1950, or the "pre-bomb" era, is 14 ± 1 disintegration per minute of carbon–14 per gram of carbon (*8*). Extensive data have been obtained on the carbon–14 content of the atmosphere (*9*), stratosphere (*1*), and the oceans (*10–13*), but only limited data exist on the content of other areas of the environment or biosphere.

[1] Mr. Drobinski is Chief, Carbon and Tritium Section, Northeastern Radiological Health Laboratory, Division of Radiological Health, 109 Holton Street, Winchester, Massachusetts.

Methodology and results

Samples were burned in an atmosphere of oxygen at 800°C. to obtain carbon dioxide and water. A detailed description of methods and apparatus used has been published elsewhere (*14*). The carbon dioxide was further purified after combustion and counted in gas proportional counters. Table 1 lists specific data for individual food items and weekly composited institutional dietary collections (*15–17*). In all cases, the samples represent edible portions.

Table 1. Carbon-14 content of foods

Sample identification	Location	Approximate date of origin	dpm of ^{14}C/g of carbon [b]
Diet [a]			
F–168	Lake Bluff, Ill	July 21, 1963	19.0±2.2
F–171–2	Lake Bluff, Ill	Aug. 25, 1963	17.6±2.6
F–173–2	Parma, Ohio	Sept. 9, 1963	17.5±2.2
F–175	Buffalo, N. Y	[c] Sept. 23, 1963	18.0±2.2
F–175–2	Buffalo, N. Y	[c] Sept. 23, 1963	17.0±2.0
F–177 (9–22) [d]	St. Louis, Mo	[c] Sept. 25, 1963	18.0±2.2
F–179	Lake Bluff, Ill	[c] Sept. 27, 1963	17.2±1.8
F–181 (9–20) [d]	Portland, Maine	Oct. 1, 1963	20.3±2.0
F–183	New York, N. Y	Oct. 1, 1963	18.5±2.2
F–183–(2)	New York, N. Y	Oct. 1, 1963	17.0±2.2
F–192	Parma, Ohio	Nov. 10, 1963	16.8±1.8
F–193	Boston, Mass	Nov. 10, 1963	17.9±2.4
F–194	Lake Bluff, Ill	Nov. 24, 1963	20.7±2.2
F–205	Edenwald, N. Y	Jan. 28, 1964	18.7±2.4
F–203	Boston, Mass	Jan. 6, 1964	14.6±2.0
Oranges	California	Feb. 1963	15.2±2.0
Oranges	Valencia, Fla	July 9, 1963	17.6±2.4
Apples–(5)	Rome, N. Y	Oct. 1962	15.7±2.0
Apples–(2)	Indiana	[c] Jan. 9, 1963	17.9±2.2
Potatoes	Virginia	[c] July 1963	20.6±2.0
Potatoes	Virginia	[c] July 1963	20.7±2.0
Eggs–(2)	Chicago, Ill	[c] July 1963	17.6±1.8
Eggs–(1)	Philadelphia, Pa	July 11, 1963	15.0±2.4
Margarine–(1–2)	Chicago, Ill	Apr. 25, 1963	19.1±2.2
Milk (evap.)	Chicago, Ill	Apr. 1963	19.6±2.0
Sucrose (#5)		Mar. 1962	19.0±2.0
Beef	Sterling, Ill	Jan. 1963	21.3±2.2

[a] Diet samples ceded with 'F-numbers' are weekly composites.
[b] Counting error is two sigma.
[c] Date of receipt at NERHL.
[d] Consumers Union sample.

Table 2 lists data derived from human postmortem samples obtained in the Boston area. The average values of 12 matched cases are 17.8, 16.6, 17.6, and 17.7 disintegrations per minute of carbon–14 per gram of carbon for kidney, heart, liver, and blood, respectively. Statistical analysis of the data from these individual cases has shown a significant linear relationship between the specific activities of carbon–14 in kidney and heart (positive cor-

Table 2. Carbon-14 in human tissue

Autopsy number	Type of sample	Age	Sex	Date of death	dpm of ^{14}C/g of carbon [a]
[b]	Liver-1	[b]	[b]	11/63	16.4±2.6
A-63-194	Liver	71	Female	12/3/63	16.6±2.2
A-63-195	Liver	55	Female	12/3/63	15.7±2.4
A-64-2	Kidney	54	Male	1/20/64	20.8±2.2
A-64-2	Heart	54	Male	1/20/64	19.1±1.8
A-64-2	Liver	54	Male	1/20/64	15.5±2.0
A-64-11	Heart	39	Female	1/20/64	17.0±2.4
A-64-11	Liver	39	Female	1/20/64	18.2±2.0
A-64-14	Heart	64	Female	1/29/64	16.1±2.0
A-64-14	Liver	64	Female	1/29/64	17.8±2.0
A-64-18	Kidney	88	Female	2/7/64	15.5±1.8
A-64-18	Liver	88	Female	2/7/64	15.5±1.6
A-64-19	Kidney	83	Female	2/7/64	16.0±1.8
A-64-19	Liver	83	Female	2/7/64	19.7±1.8
A-64-19	Heart	83	Female	2/7/64	14.8±1.6
A-64-20	Kidney	45	Female	2/7/64	16.0±1.8
A-64-20	Heart	45	Female	2/7/64	15.5±2.0
A-64-21	Heart	50	Female	2/7/64	18.0±2.0
A-64-21	Liver	50	Female	2/7/64	15.1±2.0
A-64-24	Liver	63	Male	2/2/64	20.0±2.0
A-64-25	Blood	69	Female	2/3/64	18.3±2.0
A-64-25	Heart	69	Female	2/3/64	13.3±2.0
A-64-25	Liver	69	Female	2/3/64	20.0±2.0
A-64-25	Kidney	69	Female	2/3/64	15.7±2.0
A-64-27	Kidney	43	Male	2/6/64	19.4±2.0
A-64-27	Heart	43	Male	2/6/64	18.2±2.2
A-64-32	Blood	63	Female	2/11/64	16.1±2.2
A-64-32	Kidney	63	Female	2/11/64	17.2±2.0
A-64-38	Kidney	55	Male	3/6/64	15.6±2.0
A-64-38	Heart	55	Male	3/6/64	16.1±2.0
A-64-38	Liver	55	Male	3/6/64	17.9±2.0
A-64-40	Kidney	76	Female	3/9/64	18.1±2.0
A-64-40	Heart	76	Female	3/9/64	17.5±2.0
A-64-40	Liver	76	Female	3/9/64	15.2±2.4
A-64-41	Liver	78	Female	3/10/64	16.7±1.6
A-64-42	Heart	61	Male	3/12/64	19.5±2.0
A-64-44	Kidney	45	Female	3/16/64	14.6±1.6
A-64-44	Heart	45	Female	3/16/64	15.1±2.0
A-64-44	Liver	45	Female	3/16/64	17.4±2.0
A-64-57	Heart	75	Male	4/7/64	16.3±2.0
A-64-57	Kidney	75	Male	4/7/64	17.3±2.0
A-64-58	Heart	76	Female	4/11/64	14.3±2.0
A-64-58	Liver	76	Female	4/11/64	17.0±2.2
A-64-58	Kidney	76	Female	4/11/64	16.9±2.0
A-64-98	Liver	60	Male	6/24/64	18.4±2.1
A-64-103	Kidney	61	Female	7/2/64	22.6±2.0
A-64-103	Heart	61	Female	7/2/64	[c] 18.7±2.0
A-64-103	Heart	61	Female	7/2/64	18.5±2.0
A-64-103	Liver	61	Female	7/2/64	[c] 18.7±2.2
A-64-103	Liver	61	Female	7/2/64	17.3±2.0
A-64-103	Spleen	61	Female	7/2/64	20.2±2.0
A-64-103	Blood	61	Female	7/2/64	18.7±2.0
A-64-126	Kidney	71	Female	8/13/64	18.4±2.0
A-64-129	Liver	47	Male	8/15/64	18.2±2.0
A-64-130	Heart	59	Male	[b]	20.2±2.0
A-64-130	Kidney	59	Male	[b]	20.4±2.0
A-64-130	Spleen	59	Male	[b]	18.6±2.0
A-64-130	Blood	59	Male	[b]	21.8±2.0
A-64-130	Liver	59	Male	[b]	22.1±2.0
V-11(0001)	Bone	7	Male	10/25/64	16.0±2.0

[a] Counting error is two sigma.
[b] Data not available.
[c] Recombusted.

relation coefficient of 0.94 at 5 percent confidence level), but not between the activities in liver and heart.

Table 3 gives the results to date of a study on carbon-14 activities in bull semen obtained from Cornell University and the University of Connecticut. These were chosen because of interest in genetic material.

Table 3. Radioassays of bull semen

Sample identification	Date of origin, 1964	dpm of ^{14}C/g of carbon ([a])
Bull semen #7 (Univ. of Conn.)	Feb.-Mar.	20.3±1.8
Bull semen #1 (Cornell Univ.)	Feb.-Mar.	20.6±2.2 (Station#1) 19.1±2.2 (Station#2)
Bull semen #2 (Cornell Univ.)	Apr.-May	20.9±2.0

[a] Counting error is two sigma.

The rate of entry of carbon-14 into human beings is in part determined by levels in surface air. Figure 1 presents the observed levels of carbon-14 in surface air at Winchester, Massachusetts, as previously reported (*18*). Such data can be used in conjunction with measurements of carbon-14 in other segments of the biosphere as a guide in predicting levels in food, animals, and man.

The high levels of fallout radionuclides in Alaskan Eskimos and caribou prompted an investigation of carbon-14 levels in Alaskan caribou. Table 4 depicts the levels found in caribou muscle and rumen contents in April 1964.

Table 4. Carbon-14 in Alaskan caribou [a] muscle and rumen contents, April 1964

Sample identification	Date of collection, 1964	dpm of ^{14}C/g of carbon ([b])	Percent $\Delta\,^{14}C$ ([c])
Muscle (61-822)	April	19.7±2.0	41
Muscle (61-824)	April	18.3±2.0	31
Muscle (61-824) [d]	April	20.2±2.0	44
Muscle (61-826)	April	21.2±2.0	51
Muscle (61-826) [d]	April	19.8±2.0	41
Rumen contents (65-827)	April	18.0±2.0	29
Rumen contents (65-829)	April	15.2±2.0	8
Rumen contents (65-831)	April	19.8±1.6	41

[a] Peninsula caribou—2 years old.
[b] Counting error is two sigma.
[c] Percent above natural radioactivity of 14±1 dpm of ^{14}C/g of carbon.
[d] Radioassay by Geochron Laboratories, Boston, Massachusetts.

The arithmetic means of carbon-14 levels found in the segments of the environment investigated are presented in table 5. Present levels in man and in foods are the same as those present in air in 1962 (*18*). Of the averages in table 5, those for grazing animals appear closer to those currently observed in the atmosphere, but this may not be significant because of counting errors and the small number of samples analyzed. These data, considered in relation to atmospheric trends, are helpful in the selection of samples to ascertain or estimate

Table 5. Summary of carbon-14 analytical results for various environmental samples

Type of sample	Number of samples	dpm of ^{14}C/g of carbon	Percent $\Delta\,^{14}C$ [a]
CO_2 in air	25	22.0	57
Semen [b]	4	20.2	44
Caribou muscle	5	19.8	41
Blood [c]	4	18.7	34
Food [c]	27	18.1	29
Kidney [c]	15	17.6	26
Liver [c]	21	17.6	26
Caribou rumen contents	3	17.7	26
Heart [c]	16	16.9	21

[a] Percent above natural level of 14±1 dpm/g carbon in 1950, third column data not corrected for $^{13}C/^{12}C$ isotopic ratio.
[b] Bull.
[c] Human.

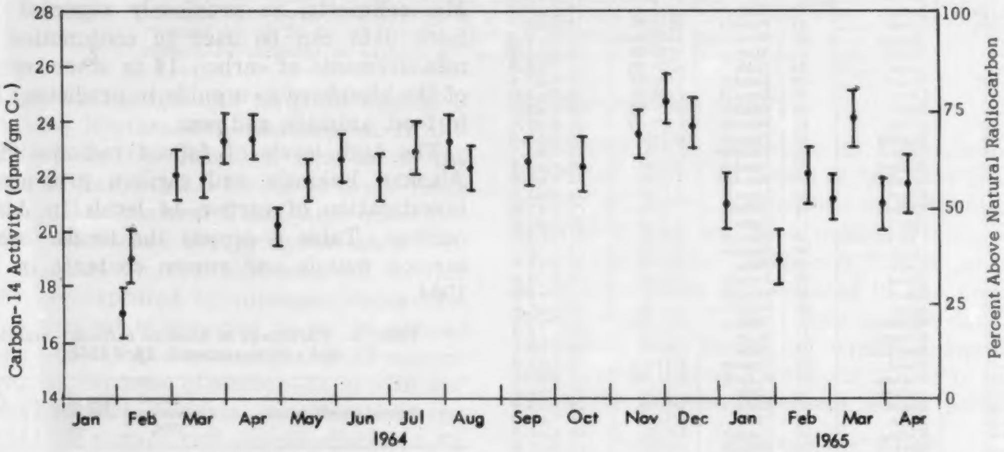

Figure 1. Carbon-14 levels in surface air, Winchester, Massachusetts

the added levels of activity that have entered and that will enter man and his environment. Libby and his associates have reported the results of limited studies on replacement rates for human tissue from atmospheric radiocarbon, and discussed the time lag between the rise in atmospheric radiocarbon and the appearance of elevated levels in food and in man (*19*). Further studies of these relationships may help in the development of models for predicting radiocarbon concentrations in human tissues.

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Section I. Milk and Food

In the determination of the internal exposure to man from environmental radiation sources, primary interest centers on radionuclides in the diet. Efforts are being made by both Federal and State agencies to monitor the intake of various radionuclides in the total diet on a continuing basis. Although the total diet is the most direct measure of intake of radionuclides, indicator foods may be used to estimate dietary intake where specific dietary data are not available. As fresh milk is consumed by a large segment of the United States population and contains most of the biologically significant radionuclides from nuclear test debris which appear in the diet, it is the single food item most often used as an indicator of the population's intake of radionuclides. Moreover, it is the major source of dietary intake of short-lived radionuclides. In the absence of specific dietary information, it is possible to approximate the total daily dietary intake of selected radionuclides as being equivalent to the intake represented by the consumption of 1 liter of milk. More direct estimates of dietary intake of radionuclides than those furnished by indicator foods can be obtained by analysis of the total diet or of representative principal food items or groups combined with appropriate consumption data.

The Federal Radiation Council has developed Radiation Protection Guides (RPG's) for controlling normal peacetime operations, assuming continuous exposure from intake by the population at large (*1–3*). The RPG's do not and cannot establish a line which is safe on one side and unsafe on the other, but they do provide an indication of when there is a need to initiate careful evaluation of exposure (*3*). Additional guidelines are provided by the International Commission on Radiological Protection (*4, 5*).

Data from selected National, International, and State milk and food surveillance activities are presented herein. An effort has been made to present a cross section of routine sampling programs which may be considered of a continuing nature. Routine sampling has been defined as one or more samples collected per month.

NATIONAL AND INTERNATIONAL MILK SURVEILLANCE

As part of continuing efforts to quantitatively monitor man's exposure to radionuclides, various National and International organizations routinely monitor radionuclide levels in milk. Data from the Pasteurized Milk Network (U.S.), Canadian Milk Network, and Pan American Milk Network are presented below.

1. Pasteurized Milk Network
September 1965

Division of Radiological Health and Division of Environmental Engineering and Food Protection, PHS

The Public Health Service's Pasteurized Milk Network (PMN) was designed to provide nationwide surveillance of radionuclide concentrations in milk through sampling from major milk production and consumption areas. The present network of 63 sampling stations (figure 1) provides data on milk levels in every State. In addition, milk is sampled in the Canal Zone and Puerto Rico. The most recent description of the sampling and analytical procedures employed by the PMN appeared in the December 1965 *Radiological Health Data* (*5*).

The results for September 1965 and third quarter of 1965 are presented in table 1. The average monthly radionuclide concentrations are based on results obtained from samples collected weekly. If radionuclide values were below minimum detectable concentrations (*5*), averages were calculated using one-half the minimum detectable value; however, for iodine–131 and barium–140, zero was used for averaging purposes when concentrations were below the minimum detectable levels.

For comparative purposes, distributions of strontium–90 and cesium–137 are presented in tables 2 and 3 for April through September 1965. The average monthly strontium–90 concentrations in pasteurized milk from selected cities in the sampling program are presented in figure 2.

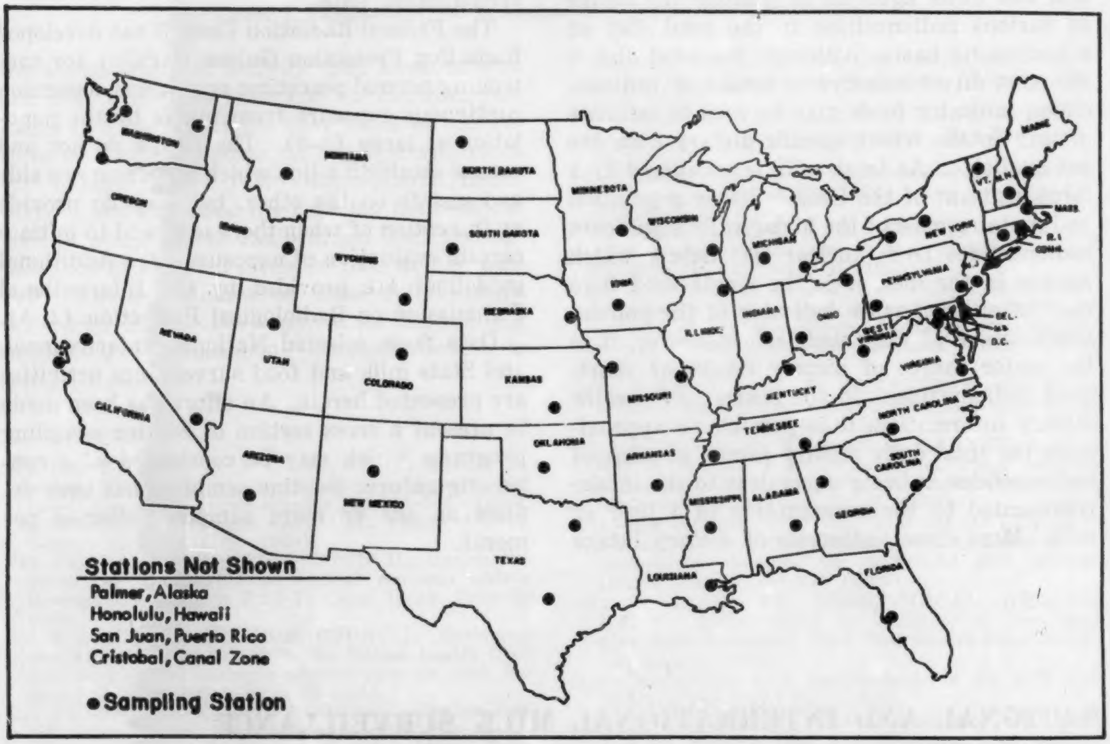

Figure 1. Pasteurized Milk Network sampling stations

Table 1. Average concentrations of stable nuclides and radionuclides in pasteurized milk for the third quarter 1965 and September 1965 [a]

Sampling locations		Calcium (g/liter)		Strontium-89 (pCi/liter)		Strontium-90 (pCi/liter)		Cesium-137 (pCi/liter)		Iodine-131 (pCi/liter)	
		Third quarter	Sept. average	Third quarter	Sept. average	Third quarter	Sept. average	Third quarter	Sept. average	Third quarter	Sept. average
Ala:	Montgomery	1.14	1.14	<5	<5	14	14	40	35	0	0
Alaska:	Palmer	1.22	1.24	<5	<5	15	14	50	60	0	0
Ariz:	Phoenix	1.22	1.24	<5	<5	4	3	20	20	0	0
Ark:	Little Rock	1.14	1.17	5	<5	28	28	50	40	0	0
Calif:	Sacramento	1.28	1.34	<5	<5	5	4	25	25	0	0
	San Francisco	1.25	1.29	<5	<5	5	3	20	20	0	0
C. Z:	Cristobal	1.10	1.11	<5	<6	4	4	30	30	0	0
Colo:	Denver	1.28	1.28	5	<5	14	11	40	35	0	10
Conn:	Hartford	1.09	1.08	<5	<5	13	12	50	40	0	0
Del:	Wilmington	1.11	1.10	<5	<5	15	14	40	30	0	0
D. C:	Washington	1.13	1.15	<5	<5	13	13	30	25	0	0
Fla:	Tampa	1.16	1.16	<5	<5	12	13	175	165	0	0
Ga:	Atlanta	1.14	1.15	<5	<5	20	20	55	45	0	0
Hawaii:	Honolulu	1.16	1.18	<5	<5	6	5	40	45	0	0
Idaho:	Idaho Falls	1.27	1.25	<5	<5	16	9	50	40	0	0
Ill:	Chicago	1.11	1.11	<5	<5	11	11	35	30	0	0
Ind:	Indianapolis	1.11	1.10	<5	<5	12	11	25	20	0	0
Iowa:	Des Moines	1.23	1.28	<5	<5	16	14	30	30	0	0
Kans:	Wichita	1.19	1.16	<5	<5	14	9	25	20	0	0
Ky:	Louisville	1.12	1.15	5	<5	18	17	25	20	0	0
La:	New Orleans	1.18	1.19	<5	<5	33	31	60	55	0	0
Maine:	Portland	1.11	1.11	5	<5	20	16	90	70	0	0
Md:	Baltimore	1.11	1.12	<5	<5	15	14	40	30	0	0
Mass:	Boston	1.10	1.09	5	<5	19	17	80	60	0	0
Mich:	Detroit	1.09	1.08	<5	<5	11	10	35	30	0	0
	Grand Rapids	1.13	1.11	<5	<5	14	13	45	40	0	0
Minn:	Minneapolis	1.28	1.28	5	<5	23	19	50	40	0	0
Miss:	Jackson	1.18	1.18	<5	<5	25	22	40	35	0	0
Mo:	Kansas City	1.21	1.27	5	<5	18	18	25	20	0	0
	St. Louis	1.22	1.25	5	<5	16	15	25	25	0	10
Mont:	Helena	1.27	1.32	5	<5	18	17	55	45	0	0
Nebr:	Omaha	1.22	1.30	<5	<5	16	16	30	30	0	0
Nev:	Las Vegas	1.20	1.15	<5	<5	5	3	20	15	0	0
N. H:	Manchester	1.11	1.09	<5	<5	21	18	105	85	0	0
N. J:	Trenton	1.09	1.08	<5	<5	14	12	40	30	0	0
N. Mex:	Albuquerque	1.24	1.22	<5	<5	6	5	20	15	0	10
N. Y:	Buffalo	1.09	1.06	<5	<5	11	11	45	35	0	0
	New York	1.09	1.08	<5	<5	17	15	55	45	0	0
	Syracuse	1.09	1.08	5	<5	12	12	40	35	0	0
N. C:	Charlotte	1.13	1.14	<5	<5	24	23	40	35	0	0
N. Dak:	Minot	1.28	1.27	10	<5	31	28	55	50	0	0
Ohio:	Cincinnati	1.11	1.11	<5	<5	13	12	25	20	0	0
	Cleveland	1.10	1.08	5	<5	13	13	35	25	0	0
Okla:	Oklahoma City	1.11	1.14	<5	<5	14	12	25	20	0	0
Ore:	Portland	1.28	1.32	<5	<5	14	12	50	45	0	10
Pa:	Philadelphia	1.08	1.09	<5	<5	13	12	35	30	0	0
	Pittsburgh	1.11	1.09	5	<5	20	18	50	40	0	0
P. R:	San Juan	1.13	1.14	<5	<5	9	9	40	30	0	0
R. I:	Providence	1.10	1.07	<5	<5	16	15	65	50	0	0
S. C:	Charleston	1.14	1.14	<5	<5	23	23	70	70	0	0
S. Dak:	Rapid City	1.04	1.04	10	<5	20	17	50	50	0	0
Tenn:	Chattanooga	1.16	1.19	<5	<5	26	25	40	30	0	0
	Memphis	1.15	1.18	5	<5	20	19	25	20	0	0
Tex:	Austin	1.12	1.11	<5	<5	5	5	20	15	0	0
	Dallas	1.11	1.12	<5	<5	12	11	25	20	0	0
Utah:	Salt Lake City	1.36	1.30	<5	<5	12	13	55	40	0	0
Vt:	Burlington	1.11	1.12	<5	<5	17	15	65	50	0	0
Va:	Norfolk	1.13	1.13	<5	<5	17	16	40	30	0	0
Wash:	Seattle	1.28	1.35	<5	<5	18	16	70	60	0	10
	Spokane	1.33	1.35	<5	<5	18	14	50	40	0	0
W. Va:	Charleston	1.12	1.14	<5	<5	18	17	25	20	0	0
Wis:	Milwaukee	1.17	1.19	<5	<5	11	12	40	40	0	0
Wyo:	Laramie	1.28	1.35	<5	<5	14	11	50	50	0	0
Network average		1.16	1.17	<5	<5	15.3	14.0	44	38	0	1

[a] All barium-140 values less than detectable levels.

Table 2. Frequency distribution, strontium-90 concentrations in milk at Pasteurized Milk Network stations, April–September 1965 and September 1964

Strontium-90 (pCi/liter)	Number of stations						
	1965						1964
	Apr	May	June	July	Aug	Sept	Sept
Under 10	5	4	7	8	10	11	8
10–19	23	26	21	34	41	44	27
20–29	27	25	29	18	11	7	20
30–39	5	5	4	3	1	1	6
40–49	2	2	2	0	0	0	2
50–59	0	0	0	0	0	0	0
60–69	1	1	0	0	0	0	0
70–79	0	0	0	0	0	0	0

Table 3. Frequency distribution, cesium-137 concentrations in milk at Pasteurized Milk Network stations, April–September 1965 and September 1964

Cesium-137 (pCi/liter)	Number of stations						
	1965						1964
	Apr	May	June	July	Aug	Sept	Sept
Under 50	7	17	19	34	45	50	14
50–99	35	31	38	25	16	12	33
100–149	18	13	5	3	1	0	13
150–199	3	2	1	1	1	1	2
200–249	0	0	0	0	0	0	1
250–299	0	0	0	0	0	0	0

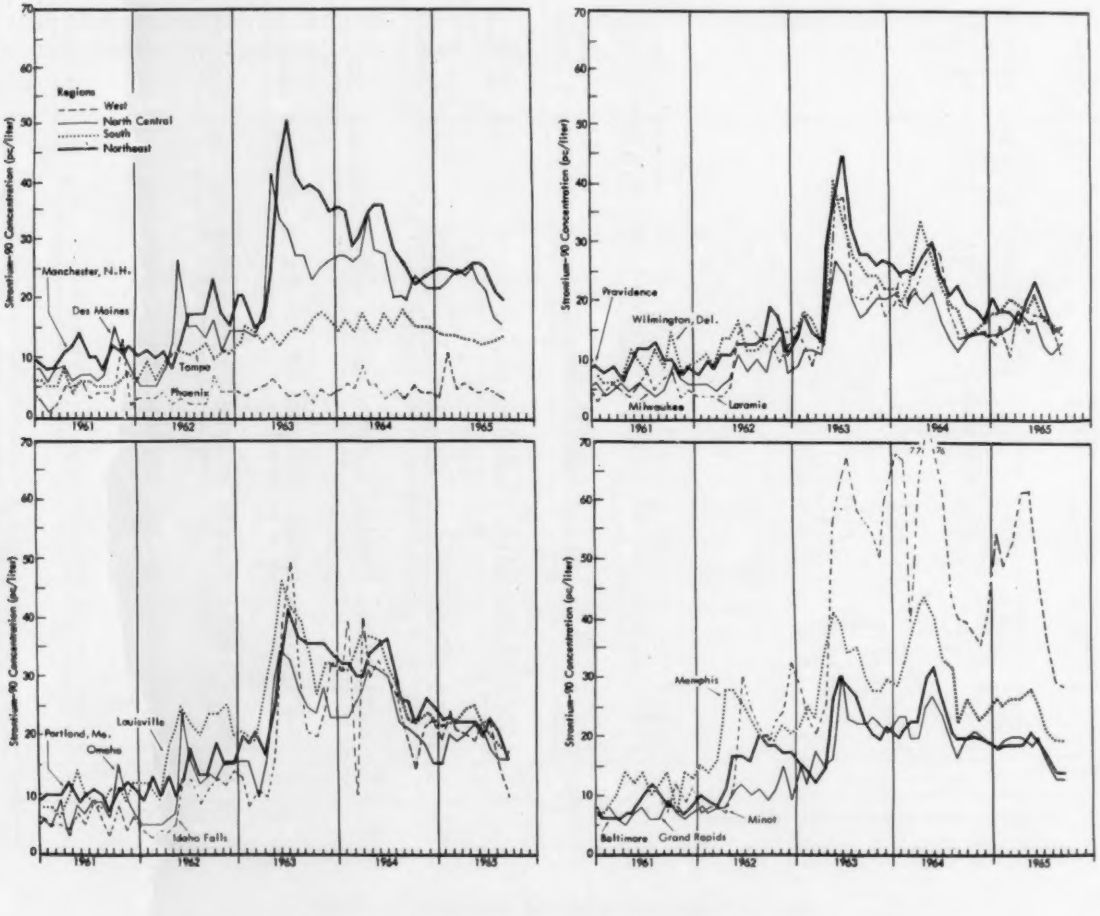

Figure 2. Strontium-90 concentrations in pasteurized milk, 1961–July 1965

2. Canadian Milk Network[1] September 1965

Radiation Protection Division
Department of National Health and Welfare, Ottawa, Canada

Since November 1955, the Radiation Protection Division of the Department of National Health and Welfare has been monitoring milk for radionuclide concentrations. Powdered milk was originally sampled, but liquid whole milk has been sampled since January 1963. At present 16 milk sampling stations (figure 3) are in operation. Their locations coincide with air and precipitation sampling stations.

Milk samples are collected three times a week from selected dairies and are combined into weekly composites. The contribution of each dairy to the composite sample is directly proportional to the liquid volume of sales. Weekly spot check analyses are made for iodine–131, and monthly composites are analyzed for strontium–90, cesium–137, and stable calcium and potassium. The analytical procedures were outlined in the December 1965 issue of *Radiological Health Data* (*6*).

The September 1965 monthly average strontium–90, cesium–137, and stable calcium and potassium concentrations in Canadian whole milk are presented in table 4. Iodine–131 and strontium–89 concentrations were below minimum detectable levels.

[1] Prepared from October 1965 monthly report "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

Table 4. Stable elements and radionuclides in Canadian whole milk, September 1965

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.15	1.6	18.7	62
Edmonton	1.16	1.6	23.7	80
Ft. William	1.13	1.6	27.4	98
Fredericton	1.14	1.6	30.4	78
Halifax	1.13	1.6	26.1	60
Montreal	1.09	1.6	16.9	41
Ottawa	1.13	1.5	15.1	53
Quebec	1.10	1.6	23.2	71
Regina	1.08	1.6	17.3	38
St. John's, Nfld	1.03	1.4	40.4	129
Saskatoon	1.16	1.6	23.8	62
Sault Ste. Marie	1.00	1.6	30.6	87
Toronto	1.13	1.5	10.8	31
Vancouver	1.16	1.5	20.0	83
Windsor	1.10	1.6	7.8	22
Winnipeg	1.09	1.6	18.8	52
Average	1.11	1.6	21.9	65

Figure 3. Canadian milk sampling stations

3. Pan American Milk Sampling Program September 1965

Pan American Health Organization and Public Health Service

The Pan American Health Organization (PAHO), in collaboration with the Public Health Service (PHS), furnishes assistance to health agencies in the American Republics in developing national radiological health programs.

Under a joint agreement between both agencies, air and milk sampling activities are conducted by a number of PAHO member countries. Sampling locations are shown in figure 4. Results of the milk sampling program are presented below. Further information on the sampling and analytical procedures employed was presented in the December 1965 issue of *Radiological Health Data* (*7*).

Table 5 presents stable calcium and potassium, strontium-89, strontium-90, and cesium-137 monthly average concentrations. The monthly average iodine-131 and barium-140 concentrations in milk were less than 10 pCi/liter.

Table 5. Stable element and radionuclide concentrations in milk, PAHO, September 1965

Sampling station	Calcium (g/liter)	Potassium (g/liter)	Strontium-89 (pCi/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Canal Zone:					
Cristobal	1.11	1.5	<5	4	30
Jamaica:					
Kingston	1.11	1.36	<5	8	175
Mandeville	NS	NS	NS	NS	NS
Montego Bay	NS	NS	NS	NS	NS
Puerto Rico:					
San Juan	1.14	1.5	<5	9	30
Venezuela:					
Caracas	1.16	1.54	<5	5	20

NS indicates no sample collected.

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Figure 4. Pan American Milk Network sampling stations

STATE MILK SURVEILLANCE ACTIVITIES

The sampling and analysis for radionuclides in milk is an integral part of comprehensive environmental surveillance programs. A number of States have developed milk surveillance programs to satisfy their needs. While there is variation between programs, to a considerable extent the data produced complements that from Federal milk surveillance activities. Data from selected State milk surveillance activities are presented below. The results presented, while not all-inclusive, are representative of current State milk surveillance activities.

1. Florida Milk Network January-June 1965

Division of Radiological and Occupational Health
Florida State Board of Health

The Florida State Board of Health began sampling raw milk for iodine-131 analysis in two major areas of the State in November 1962. The program has since been expanded to include the analysis of raw milk for strontium-89, strontium-90, iodine-131, and cesium-137 from the six areas shown in figure 1. Samples for iodine-131 analysis are taken from tank trucks or selected farms. When iodine-131 was detectable in milk, samples were collected weekly. In the interest of maintaining an active standby capability, samples are now collected and analyzed for this nuclide on a monthly basis.

For complete radiochemical analyses, the six regional State Board of Health Laboratories prepare monthly composite milk samples for each region by combining random samples from 10 percent of the dairy farms selected. These composite samples are sent to the State Radiological Health Laboratory in Orlando.

Strontium-89 and strontium-90 are determined by the ion exchange method developed by Porter *et al.* (*1*) Iodine-131 and cesium-137 are determined by gamma scintillation spectrometry (*2*).

Cesium-137 concentrations for January through June 1965 are presented in table 1. Iodine-131 concentrations were below detectable levels. Strontium-89 and strontium-90 results were not reported for this period.

Figure 1. Florida milk sampling areas

Table 1. Cesium-137 in Florida raw milk January–June 1965

Month	Concentration (pCi/liter)						
	West Florida	North Florida	North-east Florida	Central Florida	Tampa Florida	South-east Florida	Average
January	179	93	112	225	89	183	147
February	150	79	97	263	61	154	134
March	96	110	134	177	162	164	141
April	91	103	182	175	157	156	144
May	99	98	198	221	161	134	151
June	71	148	148	242	153	150	152
Average	114	105	145	188	130	156	144

2. Minnesota Milk Network January–June 1965

Division of Environmental Health
Minnesota Department of Health

In September 1958, the Minnesota Department of Health initiated a pasteurized milk network to monitor strontium-90 concentrations. Presently, monthly samples are collected from eight sampling locations in milksheds geographically the same as the Minnesota health districts (figure 2) for strontium-90, iodine-131, and cesium-137 analyses. One-liter samples of processed Grade-A fluid milk are collected at bottling machines in pasteurization plants. The samples are customarily collected in the cities where the Minnesota Health District offices are located. However, it is sometimes convenient to collect at other locations. Such samples are considered representative of the district concerned.

Strontium-90 concentrations are determined radiochemically, while iodine-131 and cesium-137 concentrations are determined by gamma scintillation spectrometry. The analytical procedures are presented in the semiannual report of the Minnesota Department of Health and Rural Cooperative Power Association (*3*).

Table 2. Strontium-90 concentrations in Minnesota milk January–June 1965

Sampling locations	Strontium-90 (pCi/liter)						
	Jan.	Feb.	Mar.	Apr.	May	June	Average
Bemidji	32	34	37	34	38	39	36
Mankato	12	12	12	15	12	16	13
Rochester	16	18	15	17	15	14	16
Duluth	29	39	36	39	36	32	35
Worthington	14	13	15	13	13	13	14
Minneapolis	24	22	21	26	27	23	24
Fergus Falls	21	21	22	18	20	19	20
Little Falls	[a] 37	20	23	19	[b] 18	22	23
Average	26	22	23	23	22	22	23

[a] Sample collected at Brainerd, near Little Falls.
[b] Sample collected at St. Cloud, near Little Falls.

Strontium-90 (table 2), iodine-131 (table 3), and cesium-137 (table 4) concentrations in milk are given for January through June 1965. The strontium-90, cesium-137, and iodine-131 concentrations in Minnesota pasteurized milk are presented graphically by milkshed in figure 3 for the period 1962–June 1965.

Figure 2. Minnesota milk sampling locations

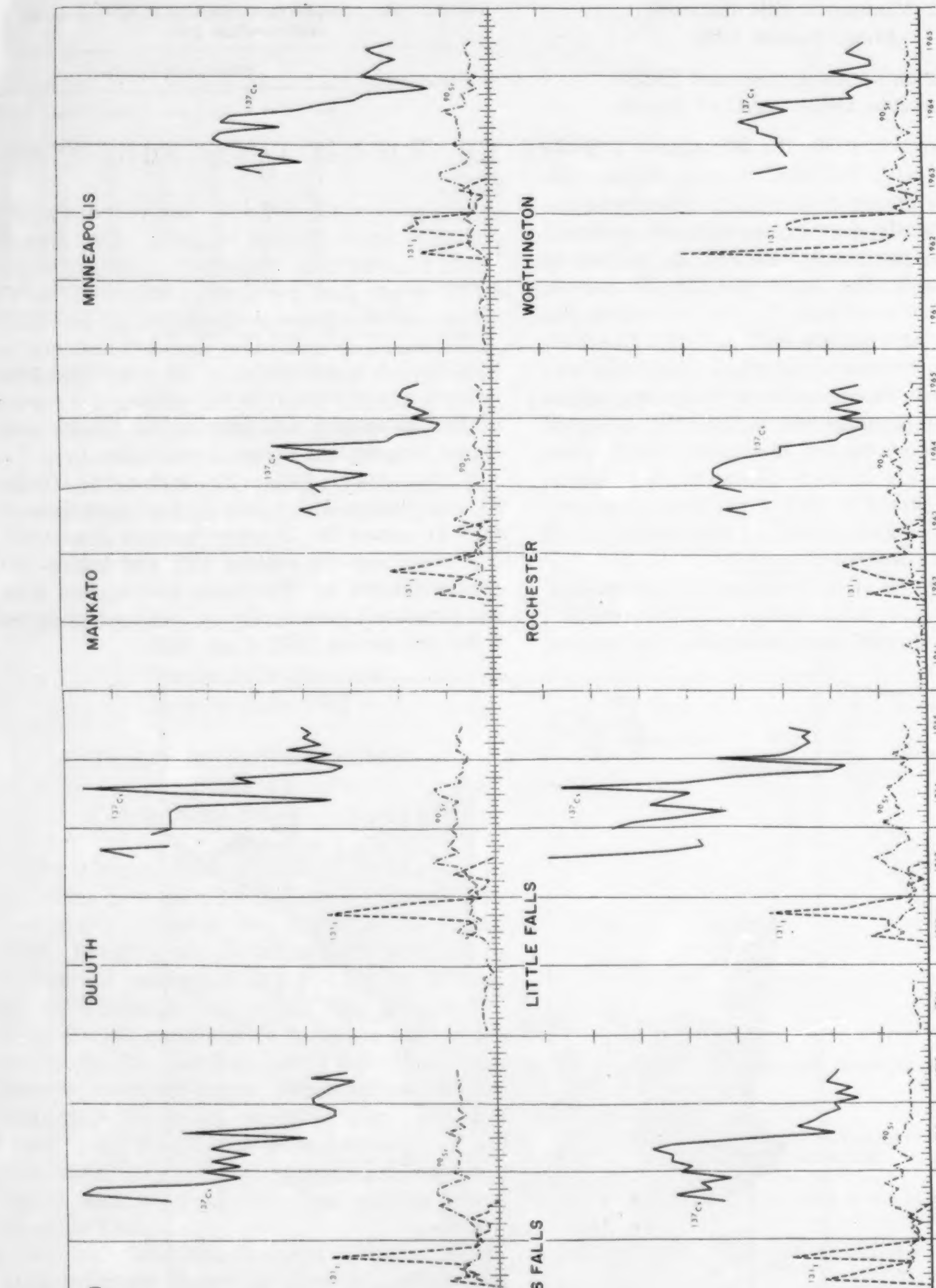

Figure 3. Radionuclide concentrations in Minnesota milk, 1961–June 1965

Table 3. Iodine-131 concentrations in Minnesota milk January–June, 1965

Collection point	Collection date	Iodine-131 (pCi/liter)
Bemidji	6/ 7/65	31
Mankato	6/ 3/65	53
Rochester	6/ 7/65	66
Rochester	6/14/65	<10
Duluth	6/ 7/65	37
Worthington	5/31/65	13
Worthington	6/ 1/65	31
Minneapolis	6/ 1/65	70
Minneapolis	6/ 8/65	59
Minneapolis	6/15/65	36
Fergus Falls	6/ 7/65	66
Little Falls	6/ 4/65	37

Note: The remaining 47 samples analyzed showed less than 10 pCi/liter.

Table 4. Cesium-137 concentrations in Minnesota milk January–June 1965

Collection point	Cesium-137 (pCi/liter)						
	Jan.	Feb.	Mar.	Apr.	May	June	Average [a]
Bemidji	190	180	170	150	190	160	175
Mankato	65	88	82	97	94	74	85
Rochester	66	97	64	82	97	65	80
Duluth	170	220	180	200	190	200	195
Worthington	94	51	52	81	71	62	70
Minneapolis	120	110	95	120	130	100	95
Fergus Falls	75	100	82	110	100	94	95
Little Falls	[b] 155	134	120	130	[c] 120	144	135
Average	115	125	110	120	125	110	115

[a] To nearest 5 pCi/liter.
[b] Sample collected at Brainerd, near Little Falls.
[c] Sample collected at St. Cloud, near Little Falls.

3. New York Milk Network April–June 1965

Division of Environmental Health Services Department of Health, State of New York

Pasteurized milk samples collected routinely from six cities (figure 4) are analyzed for strontium–89, strontium–90, iodine–131, and barium-lanthanum–140 by the New York State Department of Health. At Buffalo, Newburgh, and Syracuse milk, samples from processing plants are collected daily and composited weekly for radiochemical analyses. At Massena, samples are composited biweekly, while in New York, a milk sample representing the total milk supply for one day is obtained and composited weekly for analysis. The Albany sample, taken at a marketing point, is analyzed daily for iodine–131 and other gamma-emitting radionuclides before being composited into a weekly sample. In the event that any sample contains iodine–131 concentrations exceeding 100 pCi/liter, increased surveillance is undertaken.

Gamma-emitting radionuclides in milk are determined by scintillation spectrometry and the application of a matrix method of analysis (*4*) to the resultant spectral data.

The analytical procedure for determining strontium–89 and strontium–90 concentrations employs an ion exchange system similar to that developed by Porter *et al.* (*5*).

The monthly average radionuclide concentrations of strontium–89 and strontium–90 (table 5), and iodine–131 and cesium–137 (table 6),

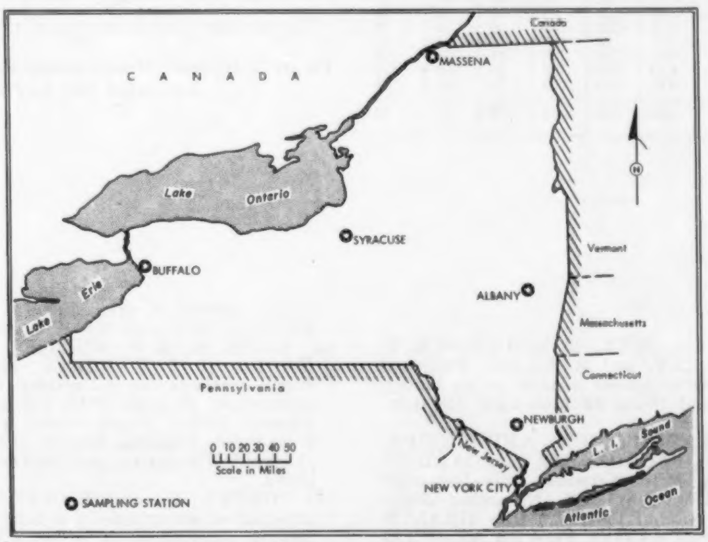

Figure 4. New York milk sampling stations

Table 5. Strontium-89 and strontium-90 concentrations in New York milk, April–June 1965

Sampling locations	Strontium-89, pCi/liter			Strontium-90, pCi/liter		
	April	May	June	April	May	June
Albany	<3	<3	4	15	15	19
Ashford	<3	NS	NS	21	NS	NS
Bedford	<3	3	7	22	28	30
Buffalo	<3	<3	6	16	39	14
Clarktown	NA	<3	<3	NA	8	6
East Otto	<3	NS	NS	14	NS	NS
Massena	<3	<3	4	20	20	20
Middleburg	<3	<3	5	15	19	15
Mount Pleasant	<3	<3	3	11	11	13
Newburgh	<3	<3	6	15	14	15
New York City	<3	<3	6	20	19	23
Oyster Bay	<3	<3	<3	16	16	14
Syracuse	<3	<3	4	13	9	9
Yaphank	<3	NS	NS	11	NS	NS
Yorkshire	<3	NS	NS	17	NS	NS
Yorktown	<3	NA	5	23	NA	18
Average	<3	<3	<3	16.4	15.8	15.6

Key to symbols: NA, no analysis
NS, no sample

are shown for April through June 1965. Cesium-137 and iodine-131 concentrations since September 1961 are presented graphically in figure 5.

Table 6. Iodine-131 and cesium-137 concentrations in New York milk, April–June 1965

Sampling locations	Iodine-131, pCi/liter			Cesium-137, pCi/liter		
	April	May	June	April	May	June
Albany	<20	<20	22	67	58	30
Ashford	<20	NS	NS	112	NS	NS
Bedford	<20	32	30	66	42	46
Buffalo	<20	<20	<20	78	67	38
Clarkstown	<20	<20	26	57	54	43
East Otto	<20	NS	NS	99	NS	NS
Massena	<20	30	<20	112	76	70
Middleburg	<20	24	64	64	69	24
Mount Pleasant	<20	<20	<20	65	46	39
Newburgh	<20	<20	25	57	60	37
New York	<20	<20	25	80	62	48
Oyster Bay	<20	<20	<20	94	74	66
Syracuse	<20	23	35	61	41	28
Yaphank	<20	NS	NS	67	NS	NS
Yorkshire	<20	NS	NS	86	NS	NS
Yorktown	<20	<20	<20	70	64	48
Average	<20	<20	<20	72	71	62

NS, no sample.

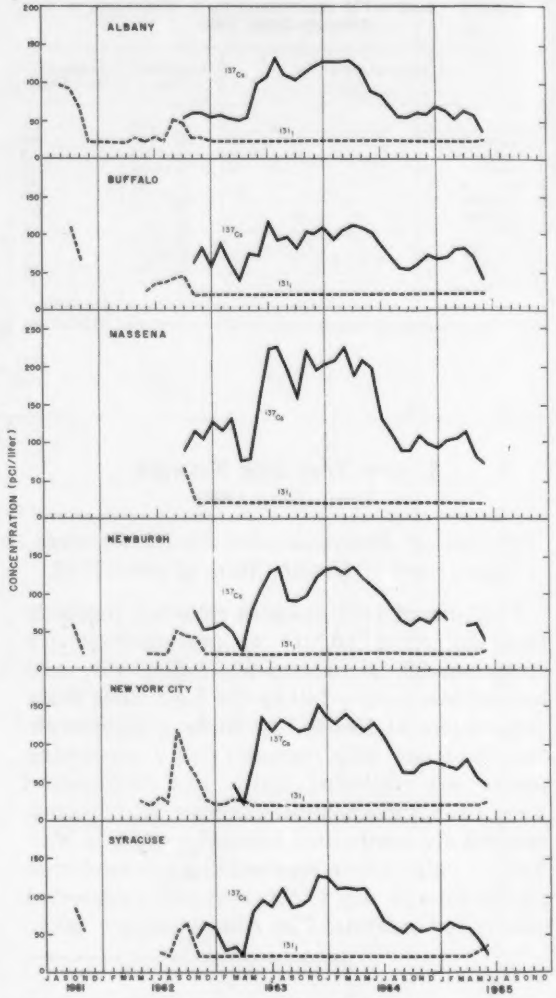

Figure 5. Cesium-137 and iodine-131 in New York milk, September 1961 to June 1965

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Other State Milk Network coverage:

Milk network	*Period reported*	*Last presented*
California	April–June 1965	*December 1965*
Colorado	October–December 1964	*April 1965*
Connecticut	January–March 1965	*August 1965*
Florida	July–December 1964	*November 1965*
Indiana	April–June 1965	*November 1965*
Michigan	January–June 1965	*November 1965*
Minnesota	July–December 1964	*July 1965*
Oklahoma	March–July 1965	*October 1965*
Oregon	January–March 1965	*August 1965*
New York	January–March 1965	*November 1965*
Pennsylvania	April–June 1965	*November 1965*
Texas	January–March 1965	*October 1965*
Washington	January–June 1965	*November 1965*

FOOD AND DIET SURVEILLANCE

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuous basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in routine operation and reported periodically include (1) the Public Health Service's Institutional Total Diet Sampling Network, (2) the Atomic Energy Commission's Tri-City Diet Study, (3) the Food and Drug Administration's Teenage Diet Study, (4) the State of California's Diet Study, and (5) the State of Connecticut's Standard Diet Study. While not based on probability sampling, these networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides.

Previous coverage:

Program	*Period reported*	*Last presented*
Institutional Total Diet	January–March 1965	*October 1965*
Tri-City Diet	February–April 1965	*December 1965*
Teenage Diet	February–November 1964	*July 1965*
California Diet	November–December 1964	*December 1965*
Connecticut Standard Diet	March 1963–December 1964	*July 1965*
Consumers Union	February 1963–June 1964	*December 1965*

Section II. Water

The Public Health Service and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and/or treated (drinking) water. Most of these programs include determinations of gross alpha and gross beta radioactivity and/or specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the values secured with the Public Health Service Drinking Water Standards (*1*). These Standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*), set the limits for radium-226 and strontium-90 as 3 pCi/liter and 10 pCi/liter, respectively, without considering other sources of radioactivity. Limits may be higher if total intake of radioactivity from all sources indicates that such intakes are within the limits recommended by FRC for control action. In the known absence [1] of strontium-90 and alpha emitters, the limit is 1,000 pCi/liter gross beta activity. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha emitters and strontium-90, respectively.

GROSS RADIOACTIVITY IN SURFACE WATERS OF THE UNITED STATES, JULY 1965

Division of Water Supply and Pollution Control, Public Health Service

Since 1957 the Public Health Service Water Pollution Surveillance System has included the monitoring of levels of radioactivity in surface waters in the United States as part of its water quality control program. Table 1 presents the current preliminary results of alpha and beta analyses. Strontium-90 results are presented quarterly. The stations on each river are arranged in the table according to their distance from the headwaters. Figure 1 geographically presents the average total beta activity in suspended-plus-dissolved solids in raw water collected at each station. The radioactivity associated with dissolved solids provides a rough indication of the levels which could occur in treated water, since nearly all suspended matter is removed by the treatment process. A description of the sampling and analytical procedures was published in the December 1965 issue of RHD (*5*).

Complete data and exact sampling locations are published in annual compilations (*6–11*) or are available on request.

Summary

Comments on the data are being made when the alpha radioactivity is 15 pCi/liter or greater or when the beta radioactivity is 150 pCi/liter or greater. Changes toward or from these levels are discussed in terms of significant

Table 1. Radioactivity in raw surface waters, July 1965, preliminary data

(Average concentrations in pCi/liter)

Station	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:						
Cedar Hill, N. Mex	14	5	19	5	0	5
Arkansas River:						
Ponca City, Okla	39	20	59	9	3	12
Atchafalaya River:						
Morgan City, La	57	16	73	32	1	33
Bear River:						
Preston, Idaho	2	30	32	0	1	1
Big Horn River:						
Hardin, Mont	33	12	45	9	3	12
Chena River:						
Fairbanks, Alaska	1	4	5	<1	1	1
Clearwater River:						
Lewiston, Idaho	2	3	5	<1	0	<1
Clinch River:						
Clinton, Tenn	1	3	4	0	0	0
Kingston, Tenn	1	36	37	0	0	0
Colorado River:						
Loma, Colo	25	10	35	6	3	9
Page, Ariz	<1	13	13	0	2	2
Parker Dam, Calif-Ariz	0	25	25	0	6	6
Columbia River:						
Wenatchee, Wash	1	6	7	0	0	0
Pasco. Wash	23	123	146	0	<1	<1
Clatskanie, Ore	16	54	70	<1	<1	<1
Connecticut River:						
Enfield Dam, Conn	2	7	9	0	0	0
Coosa River:						
Rome, Ga	1	4	5	0	0	0
Cumberland River:						
Cheatham Lock, Tenn	1	6	7	0	0	0
Delaware River:						
Philadelphia, Pa	1	8	9	0	0	0
Great Lakes:						
Duluth, Minn	0	6	6	0	0	0
Green River:						
Dutch John, Utah	25	19	44	3	4	7
Hudson River:						
Poughkeepsie, N.Y	0	8	8	0	0	0
Illinois River:						
Peoria, Ill	3	14	17	0	2	2
Kansas River:						
De Soto, Kans	94	18	112	35	2	37
Klamath River:						
Keno, Ore	1	14	15	0	<1	<1
Maumee River:						
Toledo, Ohio	1	11	12	0	0	0
Mississippi River:						
St. Paul, Minn	3	26	29	1	2	3
New Orleans, La	17	15	32	5	2	7
Missouri River:						
Williston, N. Dak	6	11	17	2	2	4
Bismarck, N. Dak	4	18	22	1	4	5
St. Joseph, Mo	93	18	111	36	3	39
Missouri City, Mo	246	16	262	70	1	71
North Platte River:						
Henry, Nebr	9	28	37	1	14	15
Ohio River:						
Toronto, Ohio	1	10	11	0	0	0
Cairo, Ill	2	8	10	1	0	1
Pend Oreille River:						
Albeni Falls Dam, Idaho	1	5	6	0	1	1
Platte River:						
Plattsmouth, Nebr	66	29	95	18	8	26
Potomac River:						
Washington, D.C	1	9	10	0	1	1
Rainy River:						
Baudette, Minn	1	19	20	0	0	0
Red River, North:						
Grand Forks, N. Dak	11	34	45	1	1	2
Red River, South:						
Alexandria, La	1	18	19	0	1	1
Rio Grande:						
El Paso, Tex	20	12	32	5	3	8
Laredo, Tex	5	18	23	1	2	3
San Joaquin River:						
Vernalis, Calif	7	14	21	1	7	8
San Juan River:						
Shiprock, N. Mex	122	12	134	38	3	41
Savannah River:						
Port Wentworth, Ga	4	11	15	<1	0	<1
Snake River:						
Payette, Idaho	1	11	12	0	5	5
Wawawai, Wash	1	4	5	0	1	1
South Platte River:						
Julesburg, Colo	13	53	66	2	36	38
Susquehanna River:						
Conowingo, Md	0	5	5	0	0	0
Tennessee River:						
Chattanooga, Tenn	1	6	7	0	0	0
Wabash River:						
New Harmony, Ind	13	11	24	3	1	4
Yellowstone River:						
Sidney, Mont	73	9	82	18	2	20
Maximum	246	123	262	70	36	71
Minimum	0	3	4	0	0	0

NS, no sample.

changes in radioactivity per unit weight of solids. No discussion of gross radioactivity per gram for all stations of the Water Pollution Surveillance System will be attempted at this time.

The following stations showed alpha values on suspended or dissolved solids of 15 pCi/liter or more for both July and the previous month:

Kansas River, De Soto, Kans.
Missouri River, St. Joseph, Mo.
Platte River, Plattsmouth, Nebr.
South Platte River, Julesburg, Colo.
Yellowstone River, Sidney, Mont.

Each of the above stations showed reasonable values for alpha radioactivity per gram of suspended or dissolved solids. The high alpha values in pCi/liter merely reflect parallel high values for solids.

The following stations, which showed a gross alpha radioactivity in suspended or dissolved solids of 15 pCi/liter or more for the previous month, declined to values of less than 15 pCi/liter for July:

Arkansas River, Ponca City, Okla.
Big Horn River, Hardin, Mont.
Rio Grande, El Paso, Tex.
Rio Grande, Laredo, Tex.

These declines in radioactivity per liter merely reflect a decline in solids levels.

The following stations showed an increase in alpha values in suspended solids from June to July:

Atchafalaya River, Morgan City, La.
San Juan River, Shiprock, N. Mex.

This increase was due to a parallel increase in suspended solids.

The Missouri City station on the Missouri River showed high alpha and beta activities in

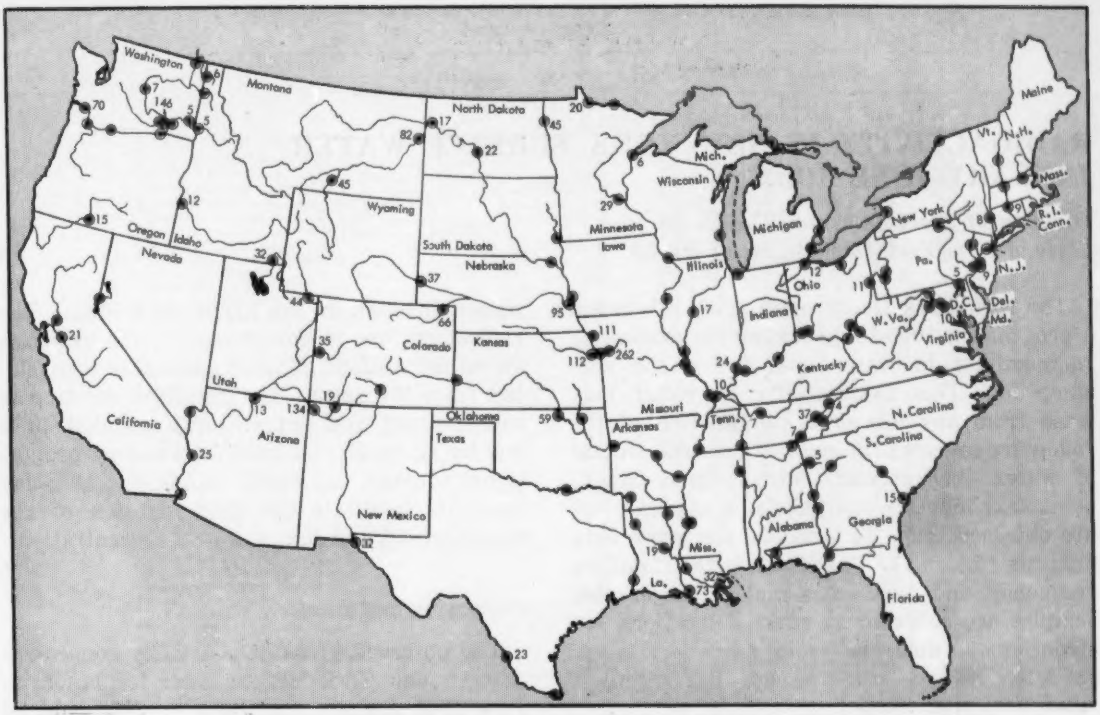

Figure 1. Sampling locations and associated total beta activity (pCi/liter) in surface waters, July 1965

suspended solids. No sample was received for June. The July sample demonstrated reasonable radioactivity per gram of suspended solids. Consequently, these values also reflect high solids content.

The station on the Platte River at Plattsmouth, Nebraska, showed a decline in gross beta activity in suspended solids from 277 pCi/liter for June to 66 pCi/liter for July. This decline was due to a parallel decrease in suspended solids. Note that this decrease also affected the alpha activity.

Although the station on the Arkansas River at Coolidge, Kansas, showed a high alpha and beta radioactivity in dissolved solids for June, no sample was received for July. These high values, however, reflected only high solids contents.

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(*10*) *Ibid.*, 1962 Edition.

(*11*) DIVISION OF WATER SUPPLY AND POLLUTION CONTROL, PUBLIC HEALTH SERVICE. Water Pollution Surveillance System, annual compilation of data. PHS Publication No. 663 (revised) 1963 Edition.[2]

[2] Single free copies of this publication may be obtained from: Public Inquires Branch. Pubilc Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C. 20201.

RADIOACTIVITY IN NEW YORK SURFACE WATER JANUARY-JUNE 1965

Division of Environmental Health Service
State of New York Department of Health

The New York Department of Health began a program in 1955 to determine the amount of radioactivity in water used for public consumption. This radioactivity in water may arise from any one or a combination of the following sources: the natural mineral content of water (background), atmospheric fallout, or nuclear industry operations. Water samples are obtained from 43 locations for gross beta analysis (figure 1). Table 1 gives the sampling frequency and type of sample. Larger size samples are collected at selected locations for strontium–90 analysis.

Analytical procedures

Beta activity concentrations are determined by evaporating a known volume of water to dryness and counting in an end-window, gas-flow proportional counter.

For strontium–89 and strontium–90 determinations, a measured volume of water is passed through an ion exchange column. The radiostrontium is complexed on the resin as strontium sulfate. The strontium is then eluted from the resin. The resultant solution is concentrated and subsequently counted in a low background, end-window, gas-flow proportional counter. Successive countings at 2-day intervals facilitate the determination of the strontium–90 and strontium–89 concentrations.

Discussion and results

The observed gross beta activity concentrations in New York surface water for January–June 1965 are given in table 1. It should be noted that the Cohoes gross beta results are for a raw water sample, while the Cohoes radiostrontium results are for a finished water.

The observed strontium–89 and strontium–90 concentrations in New York water for January through June 1965 are presented in table 2.

Figure 1. New York water sampling locations

Table 1. Gross beta activity concentrations in New York raw surface water January–June 1965

Location	Sampling	Concentration, pCi/liter					
		Jan	Feb	Mar	Apr	May	Jun
Akron (Murder Creek)	BD	9.5	9	10.5	9.5	8	NS
Auburn (Owasco Lake)	Q	NS	NS	6	NS	NS	NS
Bedford (Byram Lake)	M	6	6	8	12	4	NS
Binghamton (Binghamton Water Supply)	Q	NS	NS	6	NS	NS	NS
Canandaigua (Canandaigua Lake)	Q	NS	6	NS	NS	NS	NS
Cape Vincent (St. Lawrence River)	Q	NS	NS	7	NS	NS	NS
Cayuga (Cayuga Lake)	Q	NS	NS	6	NS	NS	NS
Clarkstown (Congers Lake)	Q	NS	NS	NS	NS	NS	13
(Lake De Forest)	M	NS	12	6	7	NS	7
Cohoes (Mohawk River)	D	5.3	7.8	5.8	10.2	6.3	NS
Elmira (Chemung River)	Q	NS	NS	3	NS	NS	NS
Geneva (Seneca Lake)	Q	5	NS	NS	NS	NS	NS
Glenmont (Hudson River)	D	5.6	8.3	5.8	6	6	NS
Hale Eddy (Delaware River)	Q	NS	NS	2	NS	NS	NS
Haverstraw (Letchworth River)	M	NS	2	2	3	NS	3
Highland Falls (Bog Meadow Brook)	M	3	3	3	3	2	NS
Lansing (Airport Well)	Q	NS	NS	NS	NS	NS	<1
(Bush Well)	Q	NS	NS	NS	NS	NS	1
(Neigh Well)	Q	NS	NS	NS	NS	NS	1
Niagara Falls (Niagara River)	M	NS	NS	8	9	NS	8
(Niagara River, West Branch)	M	NS	6	6	7	NS	7
Orangetown (Hackensack River)	Q	NS	NS	3	NS	NS	NS
Ossining (Hudson River)	D	32.3	29.5	23.4	27.5	14	23
(Indian Brook Reservoir)	M	8	9	8	7	4	NS
Oswego (Lake Ontario)	W	4.3	3.5	4.5	NS	6	6
(Oswego River)	Q	NS	NS	NS	9	NS	NS
Pawling (Pond At United Nuclear)	M	5	7	5	7	6	NS
Peekskill (Camp Field Water Supply)	M	NS	12	3	5	6	NS
(Hudson River)	D	32	20.5	12.2	18	7.3	15
Port Jervis (Delaware River)	Q	NS	4	NS	NS	NS	NS
Ramapo (Hillburn Reservoir)	BD	NS	NS	1	2	NS	3
Rome (Fish Creek)	BD	6	6	4.5	5	5	NS
Rouses Point (Lake Champlain)	Q	NS	NS	NS	NS	5	NS
Schenectady (Mohawk River)	C	5.8	5.4	5.3	5.5	4.5	NS
Seneca Falls (Cayuga Lake)	Q	NS	NS	5	NS	7	NS
Skaneateles (Skaneateles Lake)	Q	NS	NS	NS	5	NS	NS
Stony Point (Iona Island)	M	NS	2	2	NS	NS	NS
Tuxedo (Indian Kill)	M	9	7	5	5	5	NS
Waterford (Hudson River)	C	6	6.7	5.2	5.8	11.5	NS
Waterloo (Seneca River)	Q	NS	NS	7	NS	NS	NS
Watertown (Black River)	BD	5.5	8	5.5	6	8.5	NS
Watervliet (French Mills Reservoir)	BD	5	7	5	4	NS	NS
Yorktown (Croton Reservoir)	M	6	3	NS	NS	2	NS

Key to symbols: BD—Bi-weekly composite of daily grab samples.
D—Weekly composite of daily grab samples.
C—Continuous bleed-off-analyzed weekly.
W—Weekly grab sample.
M—Monthly grab sample.
Q—Quarterly grab sample.
NS—No sample collected.

Table 2. Strontium-89 and strontium-90 concentrations in New York water, January–June 1965

Sampling location	Strontium-89 concentration, pCi/liter						Strontium-90 concentration, pCi/liter					
	Jan	Feb	Mar	Apr	May	June	Jan	Feb	Mar	Apr	May	June
Albany (treated water)	<3	<3	<3	<3	<3	NS	<3	<3	4	<3	<3	NS
Ashford (Buttermilk & Frank Creek)	<3	NS	NS	<3	<3	<3	<3	NS	NS	<3	<3	4
(Hayes Hollow Bridge)	<3	NS	NS	NS	<3	<3	<3	NS	NS	NS	<3	<3
(Fox Valley Bridge)	<3	<3	<3	<3	<3	<3	<3	3	<3	<3	<3	<3
(Cattaraugus Creek at Bigelow Bridge)	<3	<3	<3	<3	NS	NS	<3	<3	<3	<3	NS	NS
(West Valley Water Supply)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Auburn	NS	NS	<3	NS	NS	NS	NS	NS	<4	NS	NS	NS
Binghamton	NS	NS	<3	NS	NS	<3	NS	NS	<3	NS	NS	<3
Canandaigua	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS	NS
Cape Vincent	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS
Cayuga	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS
Cohoes (treated water)	<3	<3	<3	<3	<3	NS	<3	<3	<4	<3	<3	NS
Concord (18 Mile Creek)	<3	NS	<3	NS	<3	NS	3	NS	<3	NS	<3	NS
Deposit	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS
East Otto (East Otto Creek)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
(Cattaraugus Creek at Scoby Hill Bridge)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
(Connoisauraley Creek)	<3	<3	<3	<3	<3	<3	<3	<3	3	<3	<3	<3
Ellicottville	<3	<3	<3	<3	<3	NS	<3	<3	<3	<3	<3	NS
Elmira	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS
Franklinville	<3	<3	<3	<3	<3	NS	<3	<3	<3	<3	<3	NS
Geneva	<3	<3	<3	<3	<3	NS	<3	<3	<3	<3	<3	NS
New York City (Ridgewood Reservoir)	<3	NS	NA	NS	NS	NS	<3	NS	NA	NS	NS	NS
(Jerome Park Reservoir)	<3	NS	<3	NS	<3	NS	3	NS	<3	NS	5	NS
(Central Park Reservoir)	NS	<3	NS	NS	NS	NS	NS	5	NS	NS	NS	NS
(Croton Water Supply)	NS	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS
Orangetown	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS
Oswego (Lake Ontario)	NS	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS
(Oswego River)	NS	NS	NS	NS	NS	NS	NS	NS	NS	<3	NS	NS
Port Jervis	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS	NS	NS
Rouses Point	NS	NS	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS
Seneca Falls	NS	NS	<3	NS	<3	NS	NS	NS	<3	NS	<3	NS
Skaneateles	NS	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS
Waterloo	NS	NS	<3	NS	NS	NS	NS	NS	<3	NS	NS	NS

Key to symbols: NA, no analysis performed
NS, no sample collected

Other State coverage:

Program	*Last presented*
California surface water sampling program	*September 1965*
Florida water sampling program	*November 1965*
Kentucky water sampling program	*March 1965*
Minnesota surface water sampling program	*August 1965*
New York surface water sampling program	*September 1965*
North Carolina water sampling program	*November 1965*
Washington surface water sampling program	*February 1965*

Section III. Air and Deposition

RADIOACTIVITY IN AIRBORNE PARTICULATES AND PRECIPITATION

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product activity. To date, this surveillance has been confined chiefly to gross beta analysis. Although such data do not provide enough information to assess total human radiation exposure from fallout, they can be used for determining when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

An intercalibration of the above networks was performed by Lockhart (*1*) in 1962.

1. Radiation Surveillance Network September 1965

Division of Radiological Health
Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Surveillance Network (RSN) which regularly gathers samples from 74 stations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

Daily samples of airborne particulates and precipitation are forwarded to the Radiation Surveillance Network Laboratory in Rockville, Maryland, where they are analyzed for gross beta activity. Selected samples are also analyzed by gamma spectrometry. The alerting function of the network is provided by routine field estimates of the gross beta activity made by the station operators prior to forwarding the samples. When high air levels are reported, appropriate officials are promptly notified. Compilation of daily field estimates and laboratory confirmations are reported elsewhere on a monthly basis (*2*). A detailed description of the sampling and analysis procedures was presented in the December 1965 issue of *Radiological Health Data.*

Figure 1. Radiation Surveillance Network sampling stations

Results

Monthly values of gross beta activity in air and precipitation are given in table 1 for September 1965. Activities remained at low levels. Of 300 air samples gamma scanned, none showed traces of fresh fission products. Time profiles of gross beta activity in air dating back to 1958 for eight RSN stations are shown in figure 2.

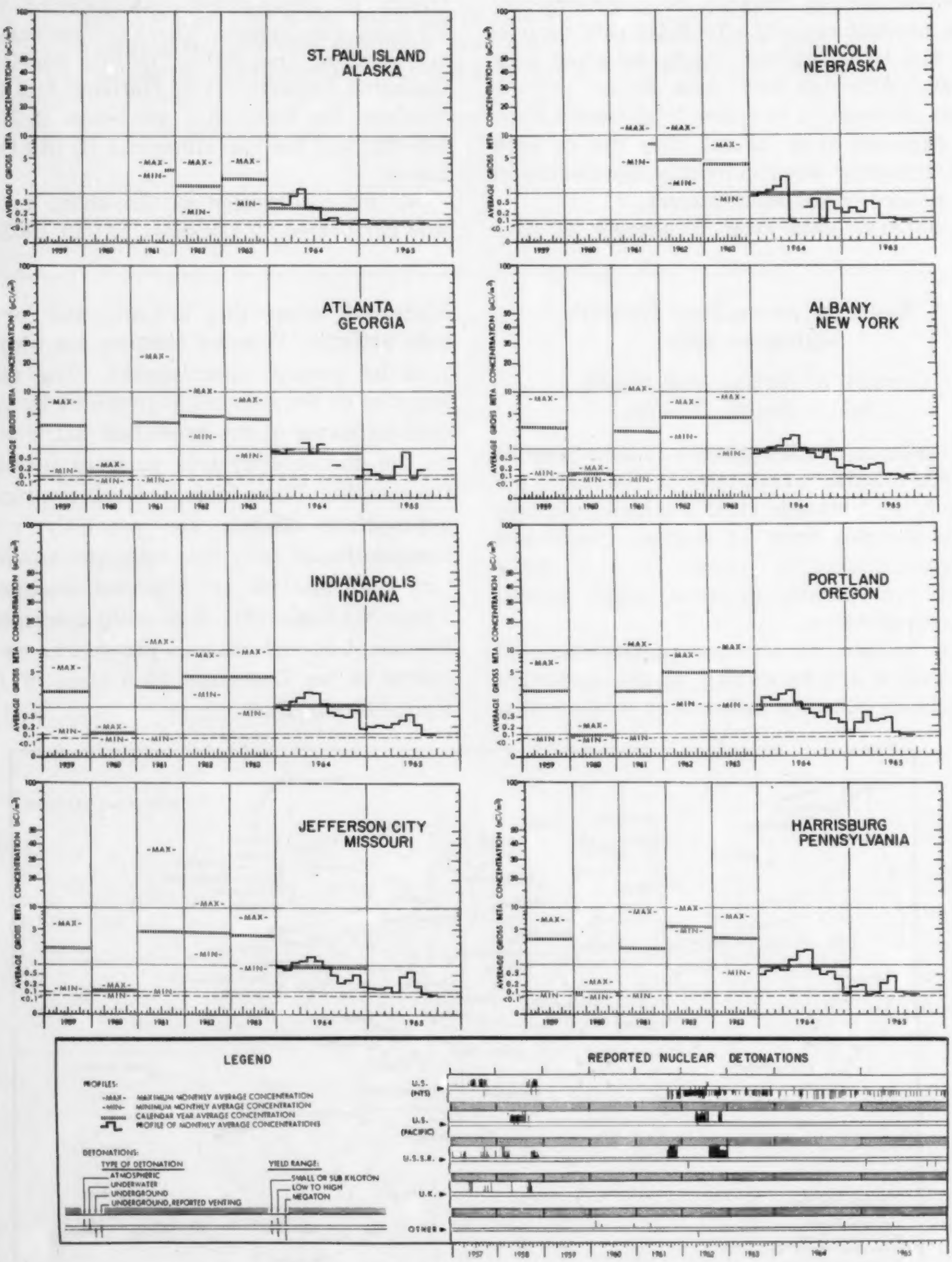

Figure 2. Monthly and yearly profiles of beta activity in air—Radiation Surveillance Network, 1959—September 1965

Table 1. Gross beta activity in surface air and precipitation, September 1965

Station location		Air surveillance: Number of samples: Air	Ppt	Gross beta activity, pCi/m³: Maximum	Minimum	Average [a]	Last profile in *RHD*	Precipitation: Total depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	30	5	.17	<.10	<.10	May 65	73	<15
Alaska:	Adak	29		.12	<.10	<.10	Sep 65	([b])	
	Anchorage	22	16	<.10	<.10	<.10	May 65	76	<15
	Attu Island	12		<.10	<.10	<.10	Oct 65	([b])	
	Fairbanks	11	4	<.10	<.10	<.10	Jun 65	26	<5
	Juneau	11	4	.16	<.10	<.10	Jul 65	44	<9
	Kodiak	6		<.10	<.10	<.10	Aug 65	([b])	
	Nome	6		<.10	<.10	<.10	Dec 65	([b])	
	Point Barrow	([c])					Nov 65	([b])	
	St. Paul Island	27		<.10	<.10	<.10	Jan 66	([b])	
Ariz:	Phoenix	28		.24	<.10	<.13	Jul 65	([b])	
Ark:	Little Rock	20	4	.16	<.10	<.11	Jun 65	152	<30
Calif:	Berkeley	20		.17	<.10	<.11	Aug 65	([b])	
	Los Angeles	30	6	.15	<.10	<.11	Dec 65	11	<2
C. Z:	Ancon	17		<.10	<.10	<.10	Aug 65	([b])	
Colo:	Denver	28	6	.28	<.10	<.12	Aug 65	77	<16
Conn:	Hartford	29	7	.12	<.10	<.10	Jul 65	64	<13
Del:	Dover	20		.16	<.10	<.11	May 65	([b])	
D. C:	Washington	29	6	.13	<.10	<.10	Nov 65	53	<11
Fla:	Jacksonville	30	10	.13	<.10	<.10	Jun 65	158	<32
	Miami	24	9	.17	<.10	<.11	Jul 65	106	<21
Ga:	Atlanta	([c])	5				Jan 66	72	<15
Guam:	Agana	29		.14	<.10	<.10	Apr 65	([b])	
Hawaii:	Honolulu	30	4	.15	<.10	<.10	Oct 65	70	<14
Idaho:	Boise	29	2	.18	<.10	<.11	Oct 65	4	<1
Ill:	Springfield	28	1	.13	<.10	<.10	Nov 65	6	<1
Ind:	Indianapolis	30	8	.12	<.10	<.10	Jan 66	129	<26
Iowa:	Iowa City	29	13	.11	<.10	<.10	Aug 63	246	<49
Kans:	Topeka	30	7	.13	<.10	<.10	May 65	140	<28
Ky:	Frankfort	29	8	.20	<.10	<.10	Nov 65	40	<8
La:	New Orleans	29	7	<.10	<.10	<.10	Nov 65	98	<20
Maine:	Augusta	30	7	.12	<.10	<.10	Dec 65	58	<12
	Presque Isle	21	7	<.10	<.10	<.10	Aug 65	93	<19
Md:	Baltimore	20	3	.15	<.10	<.11	Jul 65	26	<5
	Rockville Lab	16		.16	<.10	<.11	Oct 65	([b])	
Mass:	Lawrence	28	7	.16	<.10	<.11	May 65	129	<26
	Winchester	26	6	<.10	<.10	<.10	Sep 65	60	<12
Mich:	Lansing	30	10	.12	<.10	<.10	Oct 65	156	<31
Minn:	Minneapolis	22	9	.11	<.10	<.10	Apr 65	155	<31
Miss:	Jackson	29	5	.16	<.10	<.10	Dec 65	121	<24
Mo:	Jefferson City	30	8	.13	<.10	<.10	Jan 66	172	<35
Mont:	Helena	29	14	.20	<.10	<.11	Sep 65	94	<19
Nebr:	Lincoln	17	4	.15	<.10	<.11	Jan 66	128	<26
Nev:	Las Vegas	25		.22	<.10	<.13	Jun 65	([b])	
N. H:	Concord	20		.13	<.10	<.10	Nov 65	([b])	
N. J:	Trenton	27	3	.15	<.10	<.11	Dec 65	16	<3
N. Mex:	Santa Fe	28	8	.12	<.10	<.10	Sep 65	31	<7
N. Y:	Albany	21	11	.15	<.10	<.10	Jan 66	118	<23
	Buffalo	28		.13	<.10	<.10	Aug 65	([b])	
	New York	30		<.10	<.10	<.10	Sep 65	([b])	
N. C:	Gastonia	30	2	.16	<.10	<.11	Aug 65	17	<3
N. Dak:	Bismarck	25	12	.11	<.10	<.10	Nov 65	111	<23
Ohio:	Cincinnati	12		<.10	<.10	<.10	May 65	([b])	
	Columbus	30	7	.20	<.10	<.11	Dec 65	178	<36
	Painesville	29	8	.16	<.10	<.11	Jul 65	42	<9
Okla:	Oklahoma City	24	1	<.10	<.10	<.10	Oct 65	54	<11
	Ponca City	27	7	<.10	<.10	<.10	Jul 65	93	<19
Ore:	Portland	29	1	.27	<.10	<.16	Jan 66	1	<0
Pa:	Harrisburg	26	2	<.10	<.10	<.10	Jan 66	34	<7
P. R:	San Juan	7	4	<.10	<.10	<.10	Dec 65	34	<7
R. I:	Providence	28	5	<.10	<.10	<.10	Oct 65	42	<8
S. C:	Columbia	30	6	.13	<.10	<.10	Sep 65	146	<29
S. Dak:	Pierre	29	4	.14	<.10	<.10	Jul 65	33	<7
Tenn:	Nashville	29	7	<.10	<.10	<.10	Oct 65	59	<12
Tex:	Austin	30	8	.12	<.10	<.10	May 65	173	<35
	El Paso	28	4	.16	<.10	<.10	Nov 65	30	<6
Utah:	Salt Lake City	29	7	.29	<.10	<.13	Dec 65	60	<13
Vt:	Barre	29	7	.13	<.10	<.10	Jun 65	105	<21
Va:	Richmond	30	4	.13	<.10	<.10	Jun 65	123	<25
Wash:	Seattle	30	4	.12	<.10	<.10	May 65	18	<4
	Spokane	29	1	.14	<.10	<.10	Apr 65	2	<0
W. Va:	Charleston	29	7	.14	<.10	<.10	Sep 65	63	<13
Wisc:	Madison	30	12	<.10	<.10	<.10	Jun 65	205	<41
Wyo:	Cheyenne	30	9	.15	<.10	<.11	Jun 65	34	<8
Network summary		1,818	363	0.29	<0.10	<0.10		82	<16

[a] The monthly average is calculated by weighting the individual samples with the length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the < values represent more than 10 percent of the average, a less-than sign is placed before the average.
[b] Indicates no precipitation sample collected.
[c] Indicates no report received.

2. Canadian Air and Precipitation Monitoring Program September 1965 [1]

Radiation Protection Division
Department of National Health and Welfare,
Ottawa, Canada

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (see figure 3), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*3–7*).

A summary of the sampling procedures and methods of analysis was presented in the December 1965 issue of *Radiological Health Data.*

Surface air and precipitation data for September 1965 are presented in table 2. Specific radionuclide data are presented in table 3.

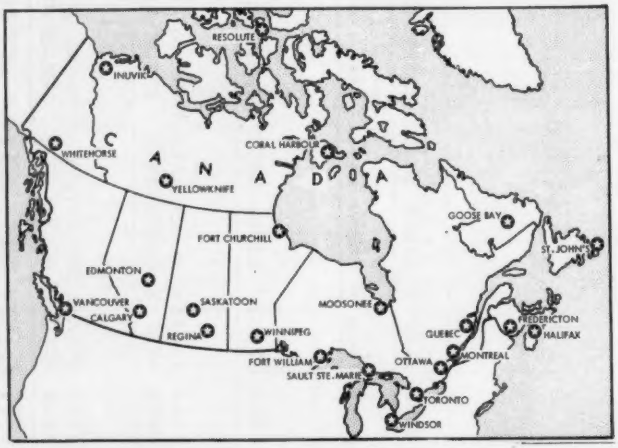

Figure 3. Canadian air and precipitation sampling stations

Table 2. Canadian gross beta activity in surface air and precipitation, September 1965

Station	Air surveillance				Precipitation measurements	
	Number of samples	Activity, pCi/m³			Average concentration (pCi/liter)	Total deposition (nCi/m²)
		Maximum	Minimum	Average		
Calgary	30	0.2	0.0	0.1	45	3.7
Coral Harbour	30	0.2	0.0	0.0	20	1.0
Edmonton	30	0.1	0.0	0.1	96	2.2
Ft. Churchill	28	0.1	0.0	0.0	32	1.5
Ft. William	30	0.1	0.0	0.1	33	5.4
Fredericton	30	0.1	0.0	0.1	45	1.7
Goose Bay	30	0.1	0.0	0.1	41	2.9
Halifax	30	0.1	0.0	0.1	52	1.5
Inuvik	30	0.2	0.0	0.0	67	1.4
Montreal	29	0.1	0.0	0.1	27	2.8
Moosonee	30	0.1	0.0	0.0	35	2.9
Ottawa	29	0.2	0.0	0.1	43	2.9
Quebec	30	0.1	0.0	0.1	19	2.9
Regina	30	0.2	0.0	0.1	45	2.5
Resolute	28	0.1	0.0	0.0	NS	NS
St. John's, Nfld	28	0.2	0.0	0.1	26	1.6
Saskatoon	24	0.1	0.0	0.1	55	1.7
Sault Ste. Marie	30	0.1	0.0	0.0	18	3.4
Toronto	30	0.1	0.0	0.1	27	1.7
Vancouver	30	0.2	0.0	0.1	120	1.8
Whitehorse	30	0.2	0.0	0.1	26	0.8
Windsor	29	0.2	0.0	0.1	23	1.3
Winnipeg	30	0.1	0.0	0.1	45	2.9
Yellowknife	30	0.1	0.0	0.0	309	1.0
Network summary	—	0.1	0.0	0.1	54	2.2

NS, no sample collected.

Table 3. Radionuclide deposition in Canadian fallout, September 1965[a] (nCi/m²)

Station	Strontium-90	Cesium-137
Calgary	0.22	0.38
Coral Harbour	0.05	0.08
Edmonton	0.17	0.22
Ft. Churchill	0.18	0.27
Ft. William	0.52	0.74
Fredericton	0.22	0.27
Goose Bay	0.73	0.20
Halifax	0.16	0.21
Inuvik	0.14	0.18
Montreal	0.18	0.31
Moosonee	0.24	0.45
Ottawa	0.19	0.34
Quebec	0.26	0.37
Regina	0.11	0.38
Resolute	NS	NS
St. John's, Nfld	0.19	0.27
Saskatoon	0.16	0.38
Sault Ste. Marie	0.34	0.40
Toronto	0.11	0.17
Vancouver	0.15	0.26
Whitehorse	0.05	0.09
Windsor	0.13	0.20
Winnipeg	0.19	0.29
Yellowknife	0.15	0.12
Average	0.21	0.29

NS, no sample collected.
[a] ^{89}Sr, ^{95}Zr, and ^{140}Ba not reported due to insignificantly low levels.

3. Mexican Air Monitoring Program September 1965

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico is operated by the Comisión Nacional de Energía Nuclear (CNEN), Mexico City. From 1952 to 1961, an earlier network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN (*8–12*).

The new Radiation Surveillance Network, operated by CNEN's Division of Radiological Protection, consists of 17 stations (see figure 4), 12 of which are located at airports and operated by airline personnel. The remaining five stations are operated by staff members of other agencies.

Sampling procedures were outlined in the December 1965 issue of *Radiological Health Data.*

Table 4 presents the maximum, minimum, and average gross beta activity concentrations in surface air during September 1965.

Table 4. Mexican gross beta activity of airborne particulates, September 1965

Station	Number of samples	Gross beta activity, pCi/m³		
		Maximum	Minimum	Average
Acapulco	17	0.1	<0.1	<0.1
Ciudad Juárez	18	0.1	<0.1	<0.1
Chihuahua	20	0.2	<0.1	0.1
Enseñada	9	0.2	<0.1	0.1
Guadalajara	14	<0.1	<0.1	<0.1
Guaymas	12	<0.1	<0.1	<0.1
La Paz	8	0.2	<0.1	<0.1
Matamoros[a]				
Mazatlán	16	0.1	<0.1	<0.1
Mérida	10	0.1	<0.1	<0.1
México, D.F.	17	0.1	<0.1	<0.1
Nuevo Laredo	5	0.1	<0.1	<0.1
San Luis Potosí	15	0.1	<0.1	<0.1
Tampico	19	0.2	<0.1	<0.1
Torréon	20	0.2	<0.1	<0.1
Tuxtla Gutiérrez[a]				
Veracruz	10	<0.1	<0.1	<0.1

[a] Temporarily shut down.

[1] Prepared from information and data in the October 1965 monthly report "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

Figure 4. Mexican air monitoring sampling locations

4. Pan American Air Sampling Program September 1965

Pan American Health Organization and Public Health Service

Gross beta activity in air is monitored by several countries in the Americas under the auspices of a collaborative program developed by the Pan American Health Organization (PAHO) and the Public Health Service (PHS) to assist PAHO-member countries in developing radiological health programs. The sampling equipment and analytical services are provided by the Division of Radiological Health, PHS, and are identical with those employed for the Radiation Surveillance Network.

The September 1965 air monitoring results from the participating countries are given in table 5. Sampling station locations are shown in figure 5.

Table 5. Gross beta activity in surface air (concentrations in pCi/m³), September 1965

Station location	Number of samples	Maximum	Minimum	Average[a]
Buenos Aires, Argentina	7	<0.10	<0.10	<0.10
Santiago, Chile	27	0.11	<0.10	<0.10
Kingston, Jamaica	10	<0.10	<0.10	<0.10
Lima, Peru	7	<0.10	<0.10	<0.10
Caracas, Venezuela	21	<0.10	<0.10	<0.10
Trinidad, West Indies	20	<0.10	<0.10	<0.10
Summary	92	0.11	<0.10	<0.10

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the < values represent more than 10 percent of the average, a less-than sign is placed before the average.

Figure 5. Pan American Air Network sampling stations

5. National Air Sampling Network July–September 1965

Division of Air Pollution
Public Health Service

The necessity of having basic data on the nature and extent of air pollution throughout the United States led to the organization of the National Air Sampling Network (NASN) in 1953. One of the many analyses performed by the NASN on their air samples is for gross beta radioactivity. NASN stations (figure 5) are manned by cooperating Federal, State, and local agencies. The network consists of 110 sampling stations which operate every year and 130 stations which operate every other year. A description of the sampling network was presented in the December 1965 issue of *Radiological Health Data.* Third quarter 1965 gross beta activities in air are given in table 6.

Previous coverage in *Radiological Health Data:*

Period	Issue
Annual Summary 1964	*April 1965*
January–March 1965	*July 1965*
April–June 1965	*October 1965*

Figure 5. National Air Sampling Network station locations

Table 6. Gross beta activity in surface air, NASN, July–September 1965

State	Station name	Number of samples	Maximum (pCi/m³)	Minimum (pCi/m³)	Average (pCi/m³)
Ala:	Birmingham	6	0.4	0.1	0.2
	Huntsville	7	0.5	<0.1	0.2
	Montgomery	6	0.2	<0.1	0.1
Ariz:	Grand Canyon Park [a]	6	0.4	0.1	0.2
	Paradise Valley	7	0.4	0.1	0.2
	Phoenix	7	0.4	<0.1	0.2
	Tucson	5	0.3	0.1	0.1
Ark:	Little Rock	6	0.4	0.1	0.2
	Montgomery County [a]	4	0.3	0.1	0.2
Calif:	Glendale	7	0.2	0.1	0.2
	Humboldt County [a]	6	0.1	0.1	0.1
	Long Beach	6	0.2	0.1	0.2
	Los Angeles	5	0.2	0.1	0.2
	Oakland	6	0.2	0.1	0.1
	San Diego	7	0.2	0.1	0.2
	San Francisco	7	0.2	0.1	0.1
Colo:	Denver	6	0.9	0.2	0.4
	Montezuma County [a]	5	0.4	<0.1	0.2
Conn:	Hartford	6	0.9	<0.1	0.3
	New Britain	7	0.9	0.1	0.3
	New Haven	5	0.9	<0.1	0.3
	Norwich	5	0.9	0.1	0.4
	Waterbury	7	1.0	0.1	0.3
Dela:	Kent County [a]	5	1.0	0.1	0.4
	Newark	6	0.4	<0.1	0.3
	Wilmington	5	0.4	0.1	0.2
D. C:	Washington	7	0.6	0.1	0.3
Ga:	Atlanta	6	0.3	<0.1	0.2
Hawaii:	Honolulu	6	0.2	0.1	0.1
Idaho:	Boise	6	0.9	0.1	0.4
	Butte County [a]	6	0.4	0.2	0.3
Ill:	Chicago	6	0.5	0.1	0.2
	East St. Louis	6	0.7	0.1	0.4
	Joliet	5	0.6	0.1	0.3
	North Chicago	4	0.4	0.2	0.3
	Rockford	7	0.7	0.1	0.3
	Springfield	6	0.5	0.1	0.3
Ind:	East Chicago	6	0.5	0.1	0.3
	Hammond	6	0.5	0.1	0.3
	Indianapolis	7	0.6	0.1	0.3
	Parke County [a]	6	0.3	0.1	0.2
	Portage	4	0.5	<0.1	0.2
	Beverly Shores	7	0.5	0.1	0.2
	Dunes Police Post #1	5	0.5	0.1	0.3
	Dunes State Park	5	0.2	0.1	0.1
	Ogden Dunes	5	0.3	0.1	0.2
	South Bend	5	0.5	0.1	0.3
	Terre Haute	3	0.4	0.1	0.2
Iowa:	Cedar Rapids	7	0.8	0.1	0.3
	Delaware County [a]	6	0.3	0.1	0.2
	Des Moines	6	0.7	0.1	0.3
Kans:	Topeka	6	0.4	0.1	0.2
	Wichita	7	0.4	0.1	0.2
Ky:	Lexington	7	0.4	0.1	0.2
	Louisville	6	0.5	0.1	0.2
La:	New Orleans	6	0.3	<0.1	0.2
	Shreveport	7	0.3	0.1	0.2
Maine:	Acadia Nat Park [a]	4	0.2	0.1	0.1
	Portland	6	0.3	0.1	0.2
Md:	Baltimore	7	0.9	<0.1	0.3
	Calvert County [a]	7	0.3	0.1	0.2
Mass:	Brockton	5	0.2	0.1	0.2
	Lawrence	6	0.5	0.1	0.2
	Lowell	3	0.2	0.1	0.2
	New Bedford	3	1.4	0.1	0.5
Mich:	Detroit	5	0.4	0.1	0.2
	Flint	6	0.3	0.1	0.2
	Grand Rapids	5	0.4	0.1	0.2
	Trenton	7	0.7	0.1	0.2
Minn:	Minneapolis	6	0.7	0.1	0.3
	St. Paul	7	0.6	0.1	0.3
Miss:	Jackson	6	0.4	0.1	0.2
	Jackson [a]	6	0.2	<0.1	0.1
Mo:	Kansas City	6	0.3	0.1	0.2
	St. Louis	6	0.5	0.1	0.2
	Shannon County [a]	6	0.4	0.1	0.2
Mont:	Glacier Nat Park [a]	5	0.6	0.1	0.2
	Helena	5	0.4	<0.1	0.2
Nebr:	Omaha	7	0.7	0.1	0.3
	Thomas County [a]	7	0.6	<0.1	0.2
Nev:	Las Vegas	7	0.8	0.1	0.3
	Reno	7	0.4	0.1	0.2
	White Pine County	5	0.2	0.1	0.2
N. H:	Concord	7	0.9	0.1	0.3
	Coos County [a]	5	0.9	0.1	0.3
N. J:	Bayonne	3	0.7	0.2	0.4
	Bridgeton	6	0.4	<0.1	0.3
N. J.—Continued					
	Pemberton	7	1.0	0.1	0.3
	Marlton	5	0.4	<0.1	0.2
	Glassboro	6	1.0	<0.1	0.3
	Hamilton	6	0.3	<0.1	0.2
	Jutland	4	0.6	0.1	0.3
	Jersey City	7	0.4	<0.1	0.2
	Newark	6	0.9	<0.1	0.3
	Paterson	6	0.7	<0.1	0.3
	Perth Amboy	7	1.0	<0.1	0.4
	Princeton	5	0.4	0.2	0.2
N. Mex:	Albuquerque	6	0.3	0.1	0.2
	Rio Arriba County	7	0.3	<0.1	0.1
N. Y:	Cape Vincent [a]	6	1.0	0.1	0.3
	New York City	6	1.1	<0.1	0.4
N. C:	Charlotte	7	0.6	0.1	0.2
	Cape Hatteras [a]	7	0.3	0.1	0.2
Ohio:	Akron	6	0.6	0.1	0.3
	Cincinnati	7	0.4	0.1	0.2
	Cleveland	7	0.5	0.1	0.3
	Columbus	6	0.7	0.1	0.3
	Toledo	7	0.5	<0.1	0.3
	Youngstown	7	0.7	<0.1	0.3
Okla:	Cherokee County [a]	7	0.4	0.1	0.2
	Oklahoma City	7	0.3	0.1	0.2
	Tulsa	6	0.3	0.1	0.2
Ore:	Curry County [a]	5	0.1	<0.1	0.1
	Eugene	7	0.4	0.1	0.2
	Medford	6	0.4	0.1	0.2
	Portland	7	0.3	0.1	0.2
Penna:	Allentown	4	0.2	0.1	0.2
	Altoona	5	1.1	0.1	0.5
	Bethlehem	5	0.4	<0.1	0.2
	Pipersville	5	0.9	0.1	0.3
	Embreeville	6	0.9	0.1	0.3
	Clarion County [a]	6	0.7	<0.1	0.2
	Erie	6	0.7	0.1	0.3
	Johnstown	6	0.7	<0.1	0.3
	Lancaster	6	1.0	<0.1	0.4
	Eagleville	4	0.8	0.1	0.3
	Sanatoga	4	0.3	<0.1	0.2
	Philadelphia	6	0.4	<0.1	0.3
	Pittsburgh	5	0.3	<0.1	0.1
	Reading	5	1.0	<0.1	0.3
	Warminster	6	0.3	0.1	0.2
	West Chester	7	0.8	<0.1	0.3
	York	7	1.0	<0.1	0.3
P. R:	Bayamon	5	0.1	<0.1	0.1
	Guayanilla	6	0.2	<0.1	0.1
	Ponce	7	0.2	0.1	0.1
	San Juan	6	0.3	<0.1	0.1
R. I:	East Providence	5	0.3	0.1	0.2
	Providence	7	0.9	0.1	0.3
	Washington County [a]	7	1.0	0.1	0.4
S. C:	Charleston	5	0.2	0.1	0.2
	Richland County [a]	3	0.1	<0.1	0.1
	Spartanburg	7	0.7	0.1	0.2
S. Dak:	Black Hills Forest [a]	7	0.3	<0.1	0.1
	Sioux Falls	7	0.8	<0.1	0.2
Tenn:	Chattanooga	5	0.2	<0.1	0.1
	Knoxville	6	0.4	<0.1	0.2
	Memphis	7	0.4	<0.1	0.2
	Nashville	5	0.4	0.1	0.2
Tex:	Dallas	7	0.3	0.1	0.2
	Houston	6	0.3	0.1	0.2
	Matagorda County [a]	6	0.2	<0.1	0.1
	San Antonio	7	0.3	<0.1	0.1
Utah:	Salt Lake City	7	0.7	0.1	0.2
Vt:	Burlington	6	0.9	<0.1	0.3
	Orange County [a]	6	0.8	0.1	0.3
Va:	Hampton	6	0.8	0.1	0.3
	Lynchburg	7	0.3	0.1	0.2
	Norfolk	6	0.9	0.1	0.3
	Shenandoah Nat Park	7	0.7	<0.1	0.3
	Portsmouth	7	0.8	0.1	0.3
	Richmond	6	1.3	<0.1	0.4
	Roanoke	6	0.8	<0.1	0.3
Wash:	Seattle	7	0.1	<0.1	0.1
W. Va:	Charleston	6	0.3	0.1	0.2
	Weirton	5	0.7	0.1	0.3
	Wheeling	7	0.6	<0.1	0.3
Wis:	Door County [a]	4	0.2	0.2	0.2
	Kenosha	6	0.7	0.1	0.3
	Madison	6	0.7	0.1	0.3
	Milwaukee	6	0.3	0.1	0.2
Wyo:	Cheyenne	6	0.6	0.1	0.3
	Yellowstone Park [a]	6	1.0	<0.1	0.3

[a] Denotes nonurban station.

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Other Air and Deposition Networks previously covered:

Network	*Period*	*Issue*
HASL Fallout	April–December 1964	*September 1965*
Canadian Fallout	October–December 1964	*September 1965*

Section IV. Other Data

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included are such typical data as those obtained from human bone sampling, bovine thyroid sampling, and environmental monitoring reports.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual." [1]

Summaries of the environmental radioactivity data follow for the Oak Ridge Area, Paducah Plant, and the Portsmouth Area Gaseous Diffusion Plant.

1. Oak Ridge Area[2] January–June 1965

Union Carbide Nuclear Company
Oak Ridge, Tennessee

Oak Ridge Area is a complex made up primarily of the Y–12 Plant, the Oak Ridge National Laboratory (ORNL), and the Oak Ridge Gaseous Diffusion Plant (ORGDP).

[1] Part 20, "Standards for Protection Against Radiation," AEC Rules and Regulations, contains essentially the standards published in the "AEC Manual." The AEC Rules and Regulations are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, on a subscription basis at $3.50 for 3 years.

[2] Summarized from Environmental Levels of Radioactivity for the Oak Ridge Area, compiled by the Applied Health Physics Section of the Health Physics Division, Oak Ridge National Laboratory.

Radioactive waste materials arising from the operation of atomic energy installations in the Oak Ridge Area are collected, treated, and disposed of according to their physical states. Solid wastes are buried in a Conasauga shale formation which has a marked ion exchange activity that enables it to fix radioactive materials. Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to trenches located in the Conasauga shale formation. Low-level liquid wastes are discharged, after preliminary treatment, to the surface streams. Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of filters, scrubbers, and/or precipitators.

Air monitoring

Atmospheric contamination by long-lived fission products and fallout occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of eight stations which encircle the plant areas (figure 1) and provide data for evaluating the impact of all Oak Ridge operations on the immediate environment. A second system consists of seven stations encircling the Oak Ridge Area at distances of from 12 to 75 miles (figure 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur.

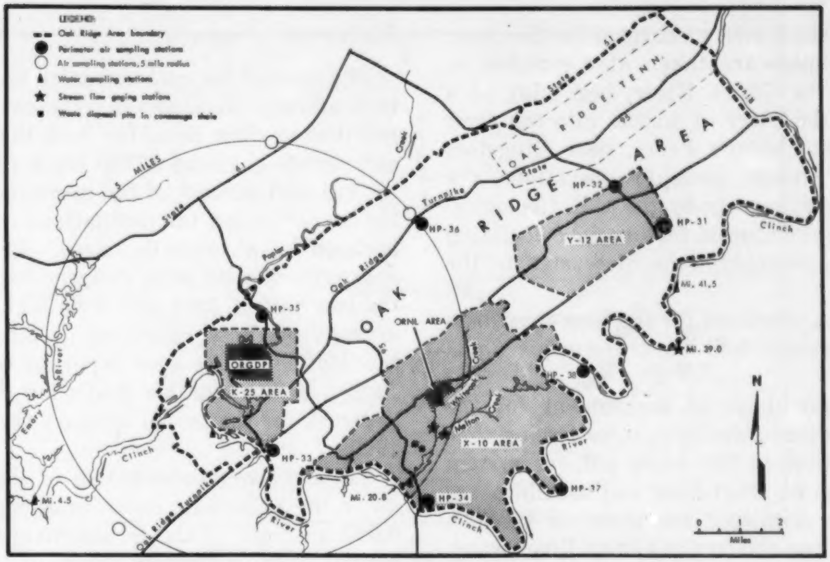

Figure 1. Oak Ridge Area environmental sampling locations

Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Average concentrations are presented in table 1. Airborne radioactive iodine is monitored in the immediate environment of the plant areas by passing air through a cartridge containing activated charcoal.

Table 1. Long-lived gross beta concentrations in air, Oak Ridge Area, average concentrations in pCi/m^3

Perimeter stations (see figure 1)	Number of samples	First half 1965	Remote stations (see figure 1)	Number of samples	First half 1965
HP-31	26	0.26	HP-51	26	0.33
HP-32	26	0.29	HP-52	26	0.24
HP-33	26	0.23	HP-53	26	0.29
HP-34	26	0.26	HP-54	26	0.29
HP-35	26	0.29	HP-55	25	0.29
HP-36	182	0.31	HP-56	25	0.27
HP-37	26	0.25	HP-57	26	0.28
HP-38	26	0.33			
Average		0.28	Average		0.28

Atmospheric contamination by alpha emitting materials, interpreted as uranium, is determined by gross alpha measurements of continuous 8-hour air samples taken at three locations on a 5-mile radius from the ORGDP (figure 1). The data are summarized in table 2.

Table 2. Long-lived gross alpha activity in air [a] five miles from ORGDP, average concentrations in pCi/m^3

Direction from plant	First half 1965
North	0.6
Northeast	0.8
Southwest	0.9

[a] Interpreted as uranium (natural).

Milk monitoring

Raw milk is monitored for iodine-131 and strontium-90 by the collection and analysis of samples from 12 sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge Area. Four stations, located more remotely with respect to Oak Ridge operations, are sampled at a rate of one station each week. The purpose of the milk sampling program is twofold: first, samples collected in the immediate vicinity of the Oak Ridge Area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples.

Water monitoring

Large volume, low-level liquid wastes originating at ORNL are discharged, after some preliminary treatment, into the Tennessee River System by way of White Oak Creek and Clinch River. Liquid wastes originating at the ORGDP and Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. The radioactivity concentration from White Oak Creek is measured, and concentration values for the Clinch River are calculated on

the basis of the dilution provided by the river.

Water samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry, near Kingston, Tennessee. Stream gauging operations are carried on continuously by the U.S. Geological Survey to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, uranium, and the transuranic alpha emitters.

Analyses are made of the effluent for the long-lived radionuclides only, since cooling time and holdup time in the waste effluent system are such that no short-lived radionuclides are present. The averages are given in table 3. No uranium was detected in Clinch River water samples during this period.

Table 3. Concentrations of major radionuclides in the Clinch River, average concentrations in pCi/liter

Radionuclide	First half 1965		
	Location on Clinch River [a]		
	Mile 41.5 (Upstream)	Mile 20.8 [b] (Outfall)	Mile 4.5 (Downstream)
^{90}Sr	0.8	1.3	1.6
^{144}Ce	0.3	<0.1	0.4
^{137}Cs	<0.1	0.4	2.5
^{106}Ru	1.6	15	17
^{60}Co	[c] ND	2.5	2.7
^{95}Zr-^{95}Nb	ND	<0.1	0.2
Gross beta	2.7	44	24

[a] The location on Clinch River is given in terms of the distance upstream from the Tennessee River. See figure 1.
[b] The concentrations at mi. 20.8 are not measured directly but the values are calculated on the basis of levels of waste released and the dilution afforded by the river.
[c] ND indicates none was detected.

Gamma measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge Area. Measurements are taken with a Geiger-Mueller tube at a distance of 3 feet above ground, and the results are shown in table 4 in terms of mR/hr.

Table 4. External gamma radiation levels, Oak Ridge area, average dose rates in mR/hr

Location	First half 1965
Solway Gate	0.014
Y-12 East Portal	0.011
Newcomb Road	0.011
Gallaher Gate	0.012
White Wing Gate	0.011
Average	0.012

Discussion of data

The average air contamination level for gross beta activity, as shown by the continuous air monitoring filter data, for both the immediate and remote environs of the plant (figure 1 and 2) was 0.28 percent of the maximum permissible concentration for populations in the neighborhood of a controlled area. This value is approximately 30 percent lower than those for the last half of 1964 and is no higher than the average of those measured in other areas of the United States and reported by the U.S. Public Health Service Radiation Surveillance Network for the period January through April 1965.

The average concentration of iodine–131 in air in the immediate environs of the plant was 0.022 pCi/m^3. This is approximately 0.022 percent of the maximum permissible concentration for populations in the neighborhood of a controlled area.

The average airborne alpha activity in the environs of the ORGDP, five miles from ORGDP, was 4.0 percent of the maximum permissible concentration for populations in the neighborhood of a controlled area.

The average concentrations of iodine–131 in raw milk in the immediate and remote environs of the Oak Ridge Area were 8.7 pCi/liter and 5.4 pCi/liter, respectively. These values fall within the limits of FRC Range I if one assumes the average intake per individual to be 1 liter of milk per day. The maximum concentration observed in any one milk sample was 75 pCi/liter. This value was measured in a sample collected the week of May 30 through June 5, 1965. During this time the East Tennessee Area was experiencing an increase in fallout from weapons testing. Laboratory analyses of samples of fallout confirmed the presence of fresh fission products consistent with the timing of the announced nuclear detonation on the Chinese mainland, May 14, 1965.[3]

The average concentration of strontium–90 in raw milk for both the immediate and remote environs of the controlled area was 17 pCi/liter. This level falls within FRC Range I for transient rates of daily intake of strontium–90 for application to the average of suitable samples of an exposed population.

[3] Radiological Health Data, Vol. 6, No. 6, p. 332 (June 1965).

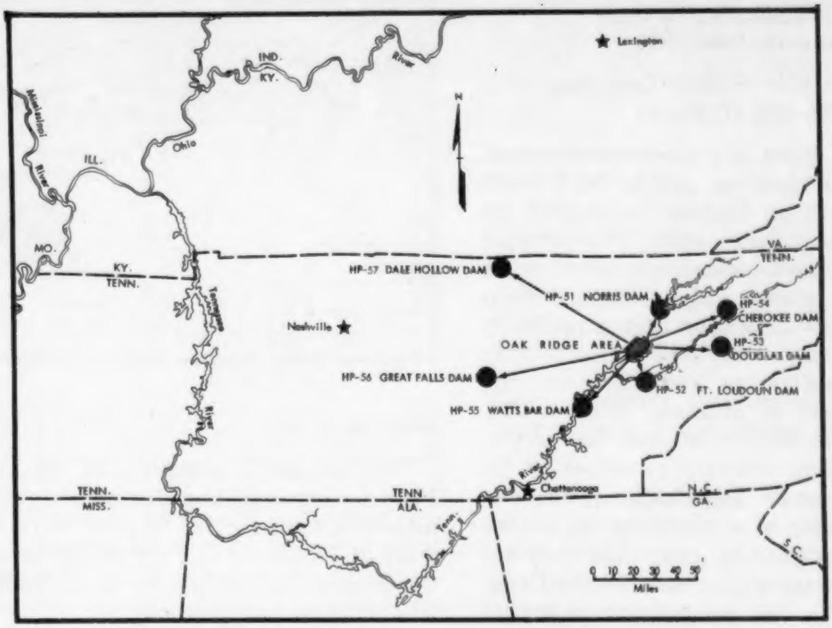

Figure 2. Remote air monitoring stations, Oak Ridge Area

The calculated average concentration of radioactivity in the Clinch River at Mile 20.8 (the point of entry of most of the wastes) and the measured average concentration at Mile 4.5 (near Kingston, Tennessee) were 44 pCi/liter and 28 pCi/liter, respectively. These values are 0.86 percent and 0.73 percent of the weighted average maximum permissible concentrations $(MPC)_w$. The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was 0.1 pCi/liter which is approximately 0.002 percent of the weighted average $(MPC)_w$ value.

The average activity of natural uranium materials in the Clinch River, reflecting the effects of all Oak Ridge plants, was <0.01 percent of the $(MPC)_w$ for uranium.

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge Area was 0.012 mR/hr, which is the same as that level measured in the early period prior to Oak Ridge operations.

Conclusion

Surveillance of the radioactivity in the Oak Ridge environs indicated that the major part of the radioactivity detected continues to be the result of fallout from weapons testing. While some low level radioactivity is being released to the environment from plant operations, the resulting concentrations in both the atmosphere and surface streams of the Oak Ridge environment are well below established maximum permissible concentrations and intake guides for the neighboring population.

Previous coverage in *Radiological Health Data:*

Period	Issue
First and second quarters 1961	*January 1962*
Third and fourth quarters 1961	*September 1962*
1962	*September 1963*
1963	*July 1964*
January–June 1964	*January 1965*
July–December 1964	*July 1965*

2. Paducah Plant
January–June 1965

Union Carbide Nuclear Company
Paducah, Kentucky

The Paducah Plant is a Government-owned gaseous diffusion plant operated by the Nuclear Division of the Union Carbide Corporation for the Atomic Energy Commission. The diffusion plant, with the associated uranium hexafluoride manufacturing plant and uranium metal foundry, processes large quantities of relatively pure uranium compounds. The major sources of external penetrating radiation are the daughter products of uranium, thorium–234, and protactinium–234, which may be concentrated by uranium recovery processes or by uranium hexafluoride vaporization. The element uranium can be a physiological hazard only if allowed to enter the body. The chemical toxicity of the uranium processed at the Paducah Plant overshadows any probable biological effects of radiation from this element, thus making it comparable as a physiological hazard to lead, mercury, or other well-known heavy metals.

Uranium is a rather expensive element, and this provides a great incentive to recover as much in any situation as is feasible. The added desire to maintain a wholesome relationship with neighboring communities and individuals makes it essential that entrained dust be filtered from exhaust systems, and that all effluent waters be maintained at extremely low concentrations of uranium.

Since no recovery process or filtering system is 100 percent efficient, an environmental monitoring program is required to evaluate the effectiveness of such measures. The Paducah Plant environmental monitoring program provides for continuously sampling air at four stations around the plant perimeter fence, and at five stations located approximately 1 mile outside this fence (figure 3). Big Bayou Creek water is sampled continuously, and grab samples are collected at five locations in the Ohio River. In addition, gamma radiation readings are taken each month at each of the air-sampling stations, with a Geiger-Mueller type meter, at a distance of 3 feet above ground level.

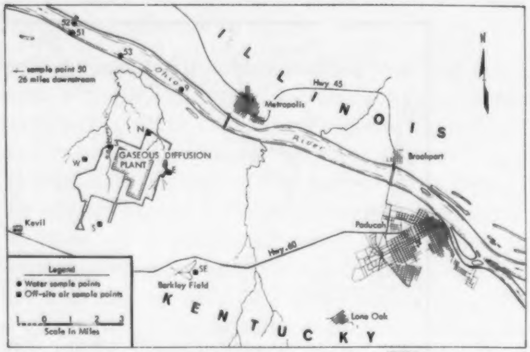

Figure 3. Water sampling locations, Paducah Plant

Basic standards

The standards observed at the Paducah Plant for exposure to radiation and radioactive materials, both for the in-plant work environment of employees and for offsite exposure of the general population, are those listed in the AEC manual (see footnote 2).

The standards specify that the radiation or radioactive materials outside a controlled area, and which have resulted from operations within the controlled area, shall be such that it is improbable that any individual may receive a dose of external radiation greater than 0.5 rem in any year and that the average exposure of a suitable population sample may not exceed one-

Table 5. Outdoor uranium air samples, Paducah Plant January–June 1965

Sample location [a]	Number of samples	Uranium alpha, [b] pCi/m³			Mean as percent of concentration limit [d]
		Maximum	Minimum [c]	Mean	
At plant perimeter fence					
N	26	0.24	<0.02	0.064	3
E	26	0.16	<0.02	0.035	2
S	26	0.23	<0.02	0.032	2
W	26	0.16	<0.02	0.036	2
Summary	104	0.24	<0.02	0.042	2
About one mile outside plant perimeter fence					
N	26	0.10	<0.02	0.032	2
E	26	0.15	<0.02	0.032	2
S	26	0.15	<0.02	0.036	2
W	26	0.21	<0.02	0.032	2
SE	26	0.18	<0.02	0.036	2
Summary	130	0.21	<0.02	0.034	2

[a] See map in figure 3.
[b] As defined in NBS Handbook 69, paragraph 3.2, a microcurie of recently extracted normal uranium corresponds to 7.57×10^4 alpha dis/sec.
[c] The minimum detectable concentration of uranium in air is 0.02 pCi/m³.
[d] The concentration limit for natural uranium in air released to the environs is 2 pCi/m³.

Table 6. Outdoor beta air samples, Paducah Plant January–June 1965

Sample location [a]	Number of samples	Beta, pCi/m³ Maximum	Minimum [b]	Mean	Mean as percent of concentration limit [c]
At plant perimeter fence					
N	26	1.8	0.2	0.60	0.06
E	26	1.0	0.1	0.44	0.04
S	26	0.8	0.1	0.35	0.04
W	26	1.0	<0.1	0.43	0.04
Summary	104	1.8	<0.1	0.45	0.05
About one mile outside plant perimeter fence					
N	26	1.1	0.15	0.42	0.04
E	26	0.9	0.11	0.36	0.04
S	26	1.1	0.16	0.41	0.04
W	26	1.1	0.13	0.41	0.04
SE	26	0.9	0.20	0.42	0.04
Summary	130	1.1	0.11	0.40	0.04

[a] See map in figure 3.
[b] The minimum detectable amount of beta emitters in air is 0.1 pCi/m³.
[c] The concentration limit applicable to this table is 1,000 pi/m³, which is the concentration limit of thorium-234, the daughter product of uranium-238. Insignificant amounts of other daughters are present in freshly refined uranium.

third of this dose. To meet this standard, the average concentration of radioisotopes in air or water beyond a controlled area should not exceed one-tenth of the maximum permitted for occupational exposure of 168 hours per week. For the purposes of such control, the concentrations of such radionuclides in air or water may be averaged over periods of time up to 1 year.

Discussion of data

Data summarizing the environmental concentrations of radioactive materials in air and water and the gamma radiation levels in the vicinity of the Paducah Gaseous Diffusion Plant are presented in tables 5 through 8.

Table 7. Concentration of uranium in water, Paducah Plant, January–June 1965

Sample location [a]	Number of samples	Uranium,[b] pCi/liter Maximum	Minimum [c]	Mean	Mean as percent of concentration limit [d]
Big Bayou Creek					
3	26	22	<1	7	0.04
Ohio River					
9	6	1	<1	<1	<0.01
Composite of 50, 51, 52, & 53	6	2	<1	<1	<0.01

[a] See map in figure 3.
[b] As defined in NBS Handbook 69, paragraph 3.2, a microcurie of recently extracted normal uranium corresponds to 7.57 x 10⁴ dis/sec.
[c] The minimum detectable uranium in water is 1 pCi/liter.
[d] The concentration limit for natural uranium in water beyond a controlled area is 20,000 pCi/liter.

Air samples are collected continuously at each of the four stations at the plant perimeter fence and at five stations at about 1 mile outside the plant. Air is filtered at 0.3 cfm through

Table 8. Concentration of beta emitters in water Paducah Plant, January–June 1965

Sample location [a]	Number of samples	Beta emitters, pCi/liter Maximum	Minimum [b]	Mean	Mean as percent of concentration limit [c]
Big Bayou Creek					
3	26	2,200	<100	210	1
Ohio River					
9	6	700	<100	170	0.9
Composite of 50, 51, 52 & 53	6	100	<100	<100	<0.5

[a] See map in figure 3.
[b] The minimum detectable amount of beta emitters in water is 100 pCi/liter.
[c] The concentration limit for the daughter products of uranium in water released to the environs is 20,000 pCi/liter.

2-inch diameter membrane filters which are replaced weekly and counted for alpha and beta activity.

The average alpha count—interpreted as uranium, the most likely source of activity—of the 234 air samples collected during the first half of 1965 was 1.9 percent of the concentration limit for people residing in the vicinity of a controlled area. The mean beta counts of the same samples were 0.04 percent of the concentration limit.

The average of uranium analyses of weekly water samples collected by a continuous water sampler in the Big Bayou was 0.4 percent of the concentration limit for water beyond a controlled area. Six grab samples were collected each month from the Ohio River, below the plant. The uranium analyses for these samples showed concentrations less than 0.01 percent of the concentration limit. The average of beta analyses for the samples from the Big Bayou was 1 percent of the concentration limit for the decay products of uranium-238 in water beyond controlled area. The average of the beta analysis for all samples of Ohio River water was <3 percent of the concentration limit when interpreted as uranium daughters.

External gamma radiation in the vicinity of the Paducah Plant averaged 0.02 mR/hour at all sampling stations.

Previous coverage in *Radiological Health Data:*

Period	Issue
January–June 1961	*January 1962*
July–December 1961	*August 1962*
1962	*September 1963*
1963	*July 1964*
January–June 1964	*February 1965*
1964	*July 1965*

3. Portsmouth Area Gaseous Diffusion Plant [3] January–June 1965

Goodyear Atomic Corporation
Piketon, Ohio

The separation of uranium isotopes by the gaseous diffusion process presents control problems similar to any chemical process using toxic solvents and extraction solutions. Natural uranium and thorium–234 are the most likely radionuclides to be released to the environment by the Portsmouth Area Gaseous Diffusion Plant. Since natural uranium is an alpha emitter and thorium–234 is a beta-gamma emitter, environmental monitoring is conducted for evidence of alpha and beta-gamma emitters to test the effectiveness of plant controls.

Continuous air samples are collected monthly at 21 sites located from 1 to 6 miles from the plant as shown in figure 4. Monthly water samples are collected at 13 stations within 5 miles of the plant.

For the first half of 1965, the average concentrations for both alpha and beta-gamma activity in the neighboring streams, creeks, and rivers, are above previously reported values. The overall averages and maximum values in off-plant waters, however, are well within permissible concentrations. For alpha activities, the average and maximum concentrations were 0.19 percent and 2.98 percent of the concentration limits, respectively, and for beta-gamma activities the average and maximum concentration values were 0.49 percent and 18 percent of the concentration limits, respectively.

The average airborne alpha activity also showed an increase compared with the past averages, while the beta-gamma airborne activity declined. The average airborne alpha activity was 16.1 percent of the concentration limit as compared to the usual 5 percent. In March and April, increases were noted and appeared to result from operating difficulties in a production area where uranium products had been released to the atmosphere during the reporting period. Two of the samples were in excess of the concentration limit for off-site locations.

Background radiation rates decreased by 36 percent from the previous 6-month period. As in the past, the onsite and offsite results are similar in trends with no appreciable difference

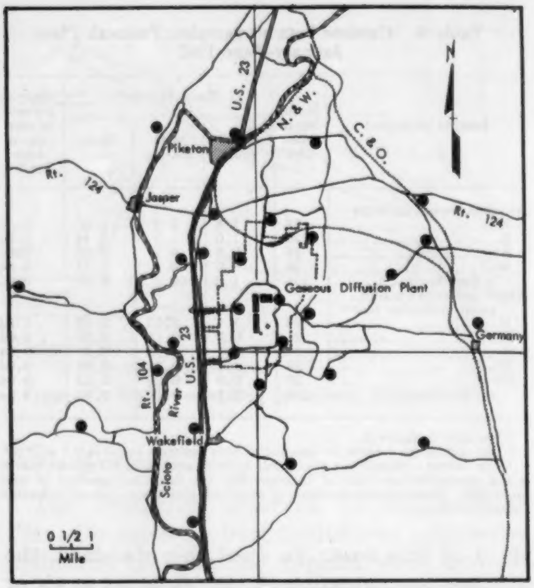

Figure 4. Air sampling locations, Portsmouth Area Gaseous Diffusion Plant

between the two average values; therefore, it is concluded that the background counting rates are due to causes other than plant operations such as natural background and fallout from past nuclear detonations.

Average alpha and beta-gamma concentrations in air and water are summarized in table 9. The external gamma levels, measured at the air sampling locations shown in figure 4, are also summarized in table 9. The overall average

Table 9. Environmental radioactivity, Portsmouth Plant

Measurement	Unit	January–June 1965				
		No. of samples	Maximum	Minimum	Average	Average as percent of concentration limit [a]
Air (alpha concentration)	pCi/m³	126	4.6	<0.1	0.3	16.1
Air (beta-gamma concentration)	pCi/m³	126	4.7	<0.1	0.5	0.05
Water (alpha concentration)	pCi/liter	74	586	<0.5	37.6	0.19
Water (beta-gamma concentration)	pCi/liter	73	3,600	<14.0	98.8	0.49
External beta-gamma [b]	mrad/hr	126	0.05	0.01	0.03	30

[a] The applicable concentration or exposure limits are as follows:
Air (alpha) 2 pCi/m^3
Air (beta-gamma) 1,000 pCi/m^3
Water (alpha) 20,000 pCi/liter
Water (beta-gamma) 20,000 pCi/liter
External beta-gamma 500 mrad/yr (approx. 0.06 mrad/hr)

[b] Measurements were made with an open shield Geiger-Mueller tube one foot above ground. The 3-foot rate (not shown) was experimentally determined to average two-thirds of the 1-foot rate and was used to determine the percent of the concentration limit.

[3] Data summarized from B. Kalmon: Environmental radiation levels and concentrations, first half 1965, GAT 505 (July 19, 1965).

concentrations and background radiation rates for January–June 1965 are presented in table 10, along with the values for the corresponding period in 1964, the second half of 1964, and the calendar year 1964.

Previous coverage in *Radiological Health Data:*

Period	Issue
First and second quatrers 1961	*February 1962*
Third and fourth quarters 1961	*September 1962*
1962	*May 1963*
1963	*July 1964*
1964	*July 1965*

Table 10. Comparison of average concentrations, Portsmouth Plant

Measurement	First half 1964	Second half 1964	Calendar 1964	First half 1965
	Percent of concentration or exposure limit [a]	Percent of concentration or exposure limit [a]	Percent of concentration or exposure limit [a]	Percent of concentration or exposure limit [a]
Water (alpha concentration)	0.06	0.07	0.07	0.19
Water (beta-gamma concentration)	<0.07	<0.07	<0.07	0.49
Air (alpha concentration)	5.0	5.50	5.0	16.1
Air (beta-gamma concentration)	0.23	0.08	0.15	0.05
Overall background exposure, extrapolated to 3 feet above ground (mrad)	47	47	48	30

[a] The applicable concentration or exposure limits are as follows:

Air (alpha)	2 pCi/m³
Air (beta-gamma)	1,000 pCi/m³
Water (alpha)	20,000 pCi/liter
Water (beta-gamma)	20,000 pCi/liter
External beta-gamma	500 mrad/yr (approx. 0.06 mrad/hr)

IODINE-131 IN BOVINE THYROIDS, JANUARY–JUNE 1965

Division of Radiological Health
Public Health Service

To supplement its existing environmental radiation surveillance systems, the Division of Radiological Health in October 1964 established a Bovine Thyroid Network (*1*). Specimens are collected by the Meat Inspection Division, U.S. Department of Agriculture, and analyzed for iodine–131 content at the Northeastern Radiological Health Laboratory, Winchester, Massachusetts.[1]

Details of sampling and analysis have been published earlier (*1*). Data for January through June 1965 appear in table 1 (page 48). The influx of fallout iodine–131 following the mainland China atmospheric nuclear detonation of May 14, 1965, was clearly evident in samples collected in June 1965. A discussion of bovine thyroid results in relation to other environmental sampling results following the second Chinese test appeared earlier (*2*).

REFERENCES

(*1*) BARATTA, E. J., E. R. WILLIAMS, and G. MURRAY. Iodine–131 in bovine thyroids, October–December 1964. Rad Health Data 6:573–578 (October 1965).

(*2*) DIVISION OF RADIOLOGICAL HEALTH, PHS. Detection of fresh fission product material in environmental samples following the second nuclear detonation on the Chinese Mainland. Rad Health Data 6:587–589 (October 1965).

[1] The samples are analyzed under the direction of Mr. E. J. Baratta.

Table 1. Iodine-131 in bovine thyroids, January–June 1965

State and county of origin	Date of slaughter (1965)	Number of samples	Age in years	pCi iodine-131/g thyroid: Average	Minimum	Maximum
Ariz:						
Unknown	2/18	2	Unknown	[a] ND		
Maricopa	5/6	1	1	ND		
Calif:						
Fresno	1/6	1	4	ND		
Fresno	1/8	1	4	ND		
Solano	1/11	1	4	ND		
Merced	1/13	2	4–5	ND		
San Joaquin		1	4	ND		
Solano		1	4	ND		
San Bernardino	1/19	2	6–7	<1	ND	[a] 1.1±0.9
Merced	2/1	1	5	ND		
Monterey	2/9	1	5	ND		
Monterey	2/15	2	8–9	ND		
Merced	2/16	2	7–8	ND		
Sacramento	2/17	2	9–10	ND		
Los Angeles	2/18	2	6	ND		
Stanislaus		1	6	ND		
Los Angeles	2/19	2	6–8	ND		
Los Angeles	2/23	1	5	ND		
San Bernardino		1	6	ND		
San Joaquin		2	5–6	ND		
Santa Barbara		1	5	ND		
Monterey	2/24	2	7	ND		
Fresno	2/25	2	6–7	ND		
Los Angeles		4	5–6	ND		
San Joaquin	2/26	3	5–7	ND		
Madera	3/1	1	6	ND		
Tulare		1	7	ND		
Marin	3/2	1	5	ND		
Riverside	3/2	2	6	ND		
Santa Cruz		2	5–6	ND		
Solano		1	7	ND		
Los Angeles	3/3	9	4–5	ND		
Shasta		1	6	ND		
Stanislaus		1	5	ND		
Unknown [b]	3/4	2	5	ND		
Los Angeles		1	4	ND		
Madera		1	2	ND		
San Joaquin		1	6	ND		
Los Angeles	3/5	2	5	ND		
Monterey		2	6–7	ND		
Los Angeles	3/8	2	5–6	ND		
Madera		2	6–7	ND		
Tulare		2	6	ND		
Fresno	3/9	2	6–7	ND		
Los Angeles		1	8	ND		
San Bernardino		1	5	ND		
Los Angeles	3/10	1	4	ND		
Orange		2	5	ND		
San Bernardino		1	5	ND		
San Joaquin		2	7–8	ND		
Tulare		2	4–6	ND		
Merced	3/11	2	8	<1	ND	1.4±0.8
San Benito	3/12	2	8	ND		
Los Angeles	3/15	2	7	ND		
Monterey		2	5–7	ND		
Los Angeles	3/16	1	5	ND		
Riverside		2	5–6	ND		
San Benito		1	7	ND		
Los Angeles	3/17	1	4	ND		
San Joaquin		1	7	ND		
Fresno	3/18	2	5–8	ND		
Los Angeles		1	3	ND		
San Joaquin	3/19	1	7	ND		
Riverside	3/22	2	6–8	ND		
Tulare		2	7	ND		
Los Angeles	3/24	1	3	ND		
Monterey		2	8–9	ND		
Merced	3/25	2	5–6	ND		
Orange		1	5	ND		
Tulare		2	10–11	<1	ND	1.3±0.9
Fresno	3/26	2	8–10	ND		
Los Angeles		2	4	ND		
Sacramento	3/29	3	7–8	ND		
Los Angeles	3/30	3	5–7	ND		
Merced		1	8	ND		
Riverside		2	6	ND		
San Bernardino	3/31	10	6	ND		
San Joaquin		2	8	ND		
San Joaquin	4/1	1	7	ND		
Sutter		1	6	ND		
Los Angeles	4/2	2	6–8	ND		
San Joaquin		2	6–7	ND		
Sonoma		2	3–5	ND		
Fresno	4/5	2	6	ND		
Tulare		1	7	ND		
Fresno	4/6	2	7	ND		
Los Angeles	4/7	1	5	ND		
Merced		2	8	ND		
San Bernardino		10	6	ND		

See footnotes at end of table, p. 53.

Table 1. Iodine-131 in bovine thyroids, January–June 1965—Continued

State and county of origin	Date of slaughter (1965)	Number of samples	Age in years	pCi iodine-131/g thyroid		
				Average	Minimum	Maximum
Calif—Continued						
Fresno	4/8	2	6–11	ND		
Los Angeles		1	7	ND		
Merced		1	8	ND		
San Benito		1	3	<1		
Los Angeles	4/9	1	7	ND		
Sacramento		1	3	ND		
San Joaquin		1	6	ND		
Monterey	4/12	2	9–10	ND		
Mariposa	4/13	2	8	ND		
Tulare		2	4–11	ND		
Fresno	4/14	2	10–11	ND		
Merced	4/15	2	5	ND		
Riverside	4/16	2	5	ND		
Monterey	4/19	2	10–11	1.4	1.2±1.0	1.5±1.3
Los Angeles	4/20	3	2–8	<1	ND	<1
San Benito		2	8–9	ND		
Los Angeles	4/21	2	Unknown	ND		
Sacramento		2	7–8	1.2	1.0±0.9	1.3±1.0
Fresno	4/22	2	7	1.0	ND	1.9±0.9
Los Angeles		10	6	>1	ND	1.4±0.9
Madera	4/23	2	5	ND		
Fresno	4/26	2	8	2.2	1.4±1.2	3.1±1.6
Los Angeles	4/27	2	7–8	ND		
Monterey		2	9–10	ND		
Santa Barbara		1	8	1.4±1.0		
Los Angeles	4/29	1	Unknown	ND		
Riverside		1	5	1.1±0.9		
San Bernardino		1	9	2.0±1.0		
San Joaquin		2	4–5	1.4	1.3±0.9	1.5±1.1
Fresno	4/30	2	6–7	2.0	1.6±1.2	2.3±1.4
San Bernardino		1	3	1.5±0.8		
Los Angeles	5/3	2	7	ND		
Merced		2	4–5	<1	ND	1.3±1.1
San Joaquin	5/4	2	8–9	1.8	1.5±0.8	2.1±1.1
Monterey	5/5	1	5	2.0±1.1		
San Joaquin		1	8	1.0±0.7		
Imperial	5/6	1	2	ND		
Los Angeles		2	7	<1	ND	<1
Merced		1	2	2.2±1.0		
Stanislaus		2	1–11	1.2	1.1±0.7	1.4±0.7
San Joaquin	5/7	1	4	ND		
Santa Clara		1	4	1.2±0.8		
Stanislaus	5/8	1	5	1.4±1.0		
Fresno	5/10	1	3	3.0±1.4		
Merced		1	5	ND		
Merced	5/11	1	5	ND		
San Joaquin		1	9	1.5±1.2		
Los Angeles	5/12	1	6	ND		
San Joaquin		2	4	1.7	1.5±1.0	1.9±1.4
Los Angeles	5/13	2	7–8	1.5	ND	2.9±1.1
Sacramento		1	4	ND		
San Bernardino		1	6	1.0±0.7		
San Joaquin		1	6	2.3±1.4		
Tulare		2	5	<1	ND	1.5±1.0
San Joaquin	5/14	2	6–8	ND		
Madera	5/17	2	6–7	ND		
Los Angeles	5/18	1	6	ND		
San Joaquin		2	6	ND		
Los Angeles	5/19	1	5	ND		
San Benito		2	6	1.0	ND	2.0±1.0
Tulare	5/20	2	6	3.5	3.0±1.0	4.0±1.0
Fresno	5/21	2	10–11	<1	ND	<1
Fresno	5/24	1	10	ND		
Los Angeles		1	4	ND		
Stanislaus		1	8	ND		
Los Angeles	5/25	3	5–8	ND		
Orange		10	6	<1	ND	2.0±1.0
San Joaquin		1	12	41±3.0		
San Luis Obispo		1	9	29±2.0		
Los Angeles	5/26	1	5	ND		
Riverside		1	3	ND		
San Joaquin		1	8	ND		
Stanislaus		1	11	4.0±2.0		
Imperial	5/27	1	3	ND		
Los Angeles		4	4–7	ND		
Tulare		2	20	50	42±1.0	58±1.0
Riverside	6/1	1	4	ND		
San Benito		2	7	12	10±1.0	14±1.0
Fresno	6/2	2	9–10	ND		
Los Angeles		3	5–8	6.0	ND	18±1.0
Los Angeles	6/3	1	5	2.0±1.0		
San Joaquin		4	5–8	62	3.0±1.0	175±2.0
Fresno	6/4	2	8–9	112	107±2.0	116±2.0
Imperial		2	3	1.0	ND	2.0±1.0
Merced		2	9–10	70	67±1.0	74±1.0
San Bernardino		1	8	ND		
Fresno	6/7	2	8	30	16±1.0	45±2.0
Madera	6/8	2	6	32	15±1.0	48±2.0
Los Angeles	6/9	3	6–7	ND		
Madera		1	8	33±1.0		
Riverside	6/9	1	8	ND		
Santa Barbara		2	4–6	ND		

See footnotes at end of table, p. 53.

Table 1. Iodine-131 in bovine thyroids, January–June 1965—Continued

State and county of origin	Date of slaughter (1965)	Number of samples	Age in years	pCi iodine-131/g thyroid		
				Average	Minimum	Maximum
Calif—Continued						
Tulare	6/10	4	4–8	49	ND	141±2.0
Merced	6/14	2	8	80	27±2.0	134±2.0
Monterey		2	7	22	4.0±1.0	39±2.0
Imperial	6/15	2	3	ND		
Madera		2	7	83	78±2.0	88±3.0
Marin		2	5	8.5	6.0±1.0	11±1.0
San Joaquin		2	6	118	101±4.0	136±2.0
Orange	6/16	1	5	ND		
San Bernardino		1	6	ND		
San Joaquin		2	6	5.0	4.0±1.0	6.0±1.0
Los Angeles	6/17	2	5–6	53	7.0±1.0	99±2.0
San Benito		1	7	ND		
San Luis Obispo	6/21	1	5	ND		
San Joaquin		1	5	32±2.0		
Stanislaus		2	8	25	17±2.0	33±2.0
Los Angeles	6/22	3	6–8	ND		
Monterey		2	8–9	52	36±2.0	68±2.0
Riverside		1	7	ND		
San Benito		1	7	18±2.0		
San Joaquin		2	6	10	9.0±2.0	12±1.0
Los Angeles	6/23	1	5	ND		
Sacramento		1	3	ND		
Los Angeles	6/25	2	3–4	13	12±2.0	14±1.0
Merced		1	4	3.0±1.0		
Tulare		1	20	19±1.0		
Los Angeles	6/28	2	5–6	5.5	2.0±1.0	9.0±1.0
Merced		6	5–10	4.0	ND	13±2.0
Monterey		1	7	48±3.0		
Los Angeles	6/29	1	7	ND		
Orange		1	6	6.0±1.0		
Riverside		1	8	ND		
San Bernardino		1	4	5.0±1.0		
San Joaquin	6/30	2	9	9.0	7.0±3.0	11±1.0
Colo:						
Weld	1/20	1	8	ND		
Jefferson	1/22	1	10	ND		
Morgan		1	8	ND		
Montezuma	1/25	1	6	ND		
Montezuma	1/26	1	6	1.4±0.9		
Montezuma	1/27	1	9	ND		
Morgan		4	6–9	<1	ND	1.4±0.7
Montezuma	1/28	1	6	ND		
Morgan	2/8	1	6	ND		
Morgan	2/9	1	7	ND		
LaPlata	2/19	1	3	ND		
Conejos	4/21	4	7–8	<1	ND	1.9±0.9
Weld	4/22	2	6	1.0	ND	2.0±1.1
Morgan	4/23	1	old range cow	2.3±1.7		
Weld		1	old range cow	23±1.1		
LaPlata	4/26	4	9–11	<1	ND	2.1±1.2
Yuma	4/29	4	2	1.2	ND	2.5±1.7
Logan	4/30	1	5	<1		
Weld	5/7	1	Unknown	ND		
Weld	5/10	1	4	ND		
Adams	5/12	1	5	1.8±1.0		
LaPlata		1	4	ND		
Weld	5/13	3	4–5	ND		
Weld	5/17	1	6	ND		
Logan	5/21	1	7	ND		
Weld	6/1	2	7	10.5	10±1.0	11±1.0
Morgan	6/7	1	8	170±2.0		
Denver	6/9	1	2	60±1.0		
Los Animas		4	4–6	26.5	5.0±3.0	49±2.0
Montezuma	6/21	5	4–12	240	ND	512±4.0
Boulder	6/23	1	4	ND		
Adams	6/24	2	5–6	120	ND	240±1.0
Elbert	6/25	5	6–8	ND		
LaPlata	6/28	4	6–7	119	62±2.0	197±2.0
Ga:						
Crawford	1/6	1	6	ND		
Hancock	1/8	1	6	ND		
Burke	1/13	1	6	ND		
Clarke	1/14	1	7	ND		
Fulton		1	6	1.9±1.3		
Wilkes		1	6	4.7±1.5		
Warren	2/4	1	8	3.4±0.9		
Pickens	2/22	1	7	ND		
Wilkes	2/25	1	9	ND		
Wilkes	3/4	1	2	ND		
Richmond	3/22	6	5–7	1.5	ND	2.5±1.0
Dade	3/26	1	6	ND		
Greene	4/16	1	11	ND		
Elbert	4/22	1	10	ND		
Wilkes		2	7–10	ND		
Richmond	4/23	1	7	2.3±1.0		
Hancock	4/30	2	6–7	1.8	1.5±0.9	2.2±0.8
Richmond	5/10	1	7	1.6±1.2		
Lincoln	5/27	1	6	ND		
Wilkes		1	7	2.0±1.0		
Columbia	6/9	1	3	36±1.0		
Butts	6/10	1	7	80±1.0		
Oconee		1	6	334±3.0		

See footnotes at end of table, p. 53.

Table 1. Iodine-131 in bovine thyroids, January–June 1965—Continued

State and county of origin	Date of slaughter (1965)	Number of samples	Age in years	pCi iodine-131/g thyroid		
				Average	Minimum	Maximum
Ga—Continued						
Wilkes		1	9	69±2.0		
Floyd	6/25	2	4	46	ND	91±1.0
Fulton		1	5	20±1.0		
Idaho:						
Bear Lake	5/4	10	2–8	35	19±0.6	52±0.9
Lemhi	5/18	7	5	2.0	1.5±0.6	3.3±0.8
Iowa:						
Lyon	6/8	8	5–10	821	35±1.0	1970±7.0
Kans:						
Jefferson	1/6	2	3	ND		
Leavenworth	3/24	1	7	ND		
Ky:						
Fayette	3/8	1	2	ND		
Clinton	3/25	3	5–7	ND		
Edmonson	6/4	1	6	404±4.0		
Harlan	6/9	1	6	379±4.0		
Metcalfe	6/29	2	6	158	119±2.0	196±3.0
Minn:						
Pipestone	2/26	2	2–5	ND		
Murray	3/25	2	7–9	ND		
Nobles	4/12	2	6–7	ND		
Nobles	4/15	2	5–6	ND		
Miss:						
Copiah	1/5	1	5	2.56±1.14		
Forrest		2	5–15	ND		
Lamar		1	15	ND		
Forrest	1/6	2	8–10	ND		
Jackson	1/8	2	6–7	ND		
Forrest	1/11	1	7	ND		
Forrest		7	4–7	ND		
Lamar		1	3	ND		
Marion		2	6–8	ND		
Forrest	1/20	8	6–8	ND		
Forrest	1/26	3	6–14	ND		
Lauderdale	1/28	1	15	ND		
Newton		1	6	ND		
Lauderdale	2/1	3	5–6	ND		
Forrest	2/5	1	5	ND		
Marion		2	6–8	ND		
Covington	2/9	6	2–7	ND		
Pearl River	2/22	2	6–7	ND		
Forrest	2/26	2	6–8	ND		
Forrest	3/4	2	9–12	ND		
Marion	3/8	3	9–11	ND		
Lamar	3/10	1	6	ND		
Forrest	3/12	2	5	ND		
Marion	3/22	10	4–10	ND		
Marion	4/2	10	4–9	ND		
N. Mex:						
Bernalillo	2/17	2	5–6	ND		
Quay		3	2–4	ND		
Bernalillo	2/24	5	5–7	ND		
Bernalillo	3/1	4	5–6	ND		
Bernalillo	3/8	5	5–8	ND		
Curry	3/10	3	6–10	ND		
San Miguel	3/15	5	3–6	ND		
Curry	3/17	4	3–6	ND		
Valencia	3/22	4	5–8	ND		
Bernalillo	3/23	3	5	ND		
Curry		21	6–10	ND		
Bernalillo	3/29	5	4–6	ND		
Curry	3/30	5	5–8	ND		
Bernalillo	4/12	4	3–10	ND		
Curry	4/13	4	5–9	ND		
Bernalillo	4/19	4	4–8	ND		
Torrance	4/28	4	9–11	<1	ND	2.3±0.9
Bernalillo	5/3	4	7–10	1.2	ND	1.9±1.3
Bernalillo	5/5	4	3–6	<1	ND	1.3±1.2
Bernalillo	5/10	4	5–7	ND		
Bernalillo	5/12	2	5	ND		
Torrance		1	8	ND		
Bernalillo	5/17	4	6–7	ND		
Torrance	5/19	4	9–12	ND		
Bernalillo	5/24	4	3–6	ND		
Bernalillo	5/26	4	3–9	4.8	ND	8.0±6.0
San Miguel	6/1	4	4–9	27	5.0±2.0	76±3.0
Bernalillo	6/2	4	3–6	46	8.0±1.0	130±3.0
Valencia	6/7	4	4–6	79	5.0±1.0	165±3.0
Bernalillo	6/14	4	5–6	45	37±2.0	54±2.0
Bernalillo	6/16	4	4–9	152	ND	442±4.0
Valencia	6/23	4	5–12	212	39±2.0	368±5.0
Bernalillo	6/30	4	4–6	30	26±1.0	52±1.0
N. Y:						
Cattaraugus	1/7	6	12	ND		
Cattaraugus	1/14	10	12	ND		

See footnotes at end of table, p. 53.

Table 1. Iodine-131 in bovine thyroids, January–June 1965—Continued

State and county of origin	Date of slaughter (1965)	Number of samples	Age in years	pCi iodine-131/g thyroid		
				Average	Minimum	Maximum
N. Y—Continued						
Cattaraugus	1/28	6	12	ND		
Cattaraugus	2/4	6	8–12	ND		
Cattaraugus	2/11	4	12	ND		
Cattaraugus	2/25	3	5	ND		
Cattaraugus	3/4	3	5–6	ND		
Chautauqua	3/11	4	5–6	ND		
Cattaraugus	3/18	6	9–11	ND		
Cattaraugus	4/1	1	11	ND		
Cattaraugus	4/22	3	10–13	ND		
Cattaraugus	4/29	4	1–14	<1	ND	1.2±0.9
Cattaraugus	5/6	8	6–15	<1	ND	1.1±0.9
Cattaraugus	5/20	3	4–14	ND		
Cattaraugus	5/21	4	1–11	<1	ND	2.4±1.2
Cattaraugus	5/27	3	7–9	66	10±2.0	146±3.0
N. Dak:						
Dickey	4/23	6	5–6	4.5	1.1±1.0	8.9±0.8
Okla:						
Cotton	4/2	1	7	ND		
S. C:						
Fairfield	5/12	2	7–8	2.8	2.3±0.8	3.2±1.1
S. Dak:						
Buffalo	1/15	21	6	ND		
Jerauld		2	7	ND		
Douglas	2/15	3	6	ND		
Lake	2/16	2	6	ND		
McCook		5	5–10	ND		
Beadle	2/24	3	3–8	ND		
Brown	2/25	3	7–14	ND		
Kingsbury		1	3	ND		
Turner	3/4	7	4–7	ND		
Aurora	3/5	1	14	ND		
Turner		1	12	ND		
Brule	3/9	5	4–8	ND		
Kingsbury		5	2–15	ND		
Turner	3/17	2	2–3	ND		
Minnehaha	3/18	1	15	ND		
Charles Mix	3/19	1	10	ND		
Turner		4	10–15	ND		
Douglas	3/25	8	6–10	ND		
Deuel	3/31	1	7	ND		
Hutchinson		1	8	ND		
Moody	4/1	1	9	ND		
Tripp	4/2	1	7	ND		
Aurora	4/7	10	5–6	ND		
Minnehaha	4/13	1	7	ND		
Brookings	4/14	2	5	ND		
Brown	5/7	1	5	1.0±0.5		
Lincoln		2	4–5	<1	ND	1.9±0.5
Minnehaha		2	5	ND		
McCook	5/11	1	3	1.6±1.1		
Turner		2	4	24	17±1.4	32±1.6
Lyman	5/13	3	5–6	7.3	ND	19±1.2
Brule	5/27	2	5–6	110	73±2.0	146±2.0
McCook		4	5–7	372	8.0±1.0	657±3.0
McCook	6/4	1	15	295±3.0		
Minnehaha		1	7	63±2.0		
Turner		6	4–15	346	165±2.0	540±3.0
McCook	6/9	1	9	116±2.0		
Turner		1	10	48±1.0		
Brown	6/24	9	8–11	154	84±2.0	235±2.0
Aurora	6/28	4	5–7	206	182±2.0	219±3.0
Minnehaha	6/30	6	4–8	177	90±2.0	228±2.0
Tenn:						
Loudon	1/8	1	2	ND		
Blount	1/14	10	3	ND		
Warren		2	3–5	<1	ND	1.5±1.4
Jefferson	2/5	1	4	ND		
Cocke	2/23	1	5	1.1±0.8		
Blount	3/8	1	4	ND		
Fayette		1	3	ND		
Fentress		1	4	ND		
Campbell	3/16	1	3	1.1±0.6		
Blount	3/25	3	2–3	ND		
Jefferson		3	5–6	1.6	1.3±1.2	1.9±1.1
Greene	3/26	3	3	ND		
Marion		3	4–6	ND		
Claiborne	5/26	1	8	7.0±1.0		
Monroe	5/27	1	9	8.0±1.0		
Anderson	6/3	4	4–7	522	439±3.0	681±6.0
Jefferson	6/7	1	6	324±3.0		
Monroe	6/8	1	2	447±4.0		
Greene	6/17	1	6	145±3.0		
Cocke	6/28	1	6	126±2.0		
Clay	6/29	1	6	83±2.0		
Tex:						
Wise	2/6	1	6	ND		
Collin	2/22	1	2	ND		
Wise	3/9	1	1	ND		

See footnotes at end of table, p. 53.

Table 1. Iodine-131 in bovine thyroids, January–June 1965—Continued

State and county of origin	Date of slaughter (1965)	Number of samples	Age in years	pCi iodine-131/g thyroid		
				Average	Minimum	Maximum
Tex—Continued						
Ellis	5/19	1	6	ND		
Johnson		1	5	ND		
Tarrant		1	7	<1		
Tarrant	6/2	1	5	25±2.0		
Johnson	6/22	1	6	60±2.0		
Tarrant		2	5	12	11±1.0	13±1.0
Utah:						
San Juan	1/8	1	4	ND		
Sanpete	3/11	1	6	ND		
Sevier		2	7	ND		
Davis	3/12	1	3	ND		
Salt Lake		3	3–7	ND		
Utah		1	3	ND		
Weber		1	3	ND		
Juab	3/24	1	7	ND		
Utah		1	7	ND		
Wasatch		1	8	ND		
Box Elder	3/25	7	4	<1	ND	1.4±1.1
Salt Lake	3/29	3	8	ND		
Salt Lake	3/31	2	3	ND		
Cache	4/1	5	5	ND		
Cache	4/2	1	5	ND		
Weber	4/15	2	5–11	ND		
Unknown		3	6–7	ND		
Sevier	5/4	3	3–4	2.6	1.2±0.5	3.6±0.8
Sevier	5/5	2	3–4	<1	ND	1.8±0.7
Utah	5/12	5	4–5	<1	ND	1.6±0.7
Millard	5/26	1	8	73±1.0		
Weber		4	8	124	6.0±1.0	305±3.0
Weber	6/10	5	6–9	164	4.0±1.0	399±6.0
Utah	6/25	4	5–6	118	7.0±4.0	216±7.0
Vt:						
Franklin	2/18	5	3–5	ND		
Orleans		5	1–6	ND		
Franklin	2/23	2	7–8	ND		
Grand Isle		10	2–6	ND		
Orange		2	7–8	ND		
Franklin	3/1	10	2–6	ND		
Franklin	3/8	5	2–10	ND		
Grand Isle		1	5	ND		
Franklin	3/9	3	2–8	ND		
Franklin	3/15	10	2–5	ND		
Franklin	3/24	5	5–9	ND		
Orange		1	8	<1		
Franklin	4/5	8	5–9	ND		
Franklin	4/12	10	2–8	ND		
Franklin	4/19	5	3–6	ND		
Franklin	4/26	10	2–6	ND		
Franklin	5/3	9	4–8	<1	ND	<1
Franklin	5/10	10	3–6	ND		
Franklin	5/17	10	5–10	ND		
Franklin	6/1	8	3–8	29	3.0±1.0	45±1.0
Franklin	6/2	10	4	ND		
Franklin	6/14	6	5–9	126	11±1.0	224±2.0
Franklin	6/15	10	3–6	ND		
Franklin	6/29	16	2–7	16	ND	78±1.0
Wyo:						
Lincoln	5/18	1	4	<1		

[a] ND indicates observed value equal to or less than 2σ counting error.
[b] Purchased in Los Angeles County.
[c] Counting error is 2 standard deviations.

REPORTED NUCLEAR DETONATIONS, DECEMBER 1965

Three United States nuclear tests were announced by the Atomic Energy Commission during December 1965. All of the tests were conducted underground at the Nevada Test Site. A test of intermediate yield (200 kilotons to one megaton of TNT equivalent) was conducted on December 3. Two tests were conducted on December 16, one of low yield (less than 20 kilotons), and the other of low-intermediate yield (20 to 200 kilotons of TNT equivalent).

A British nuclear test, conducted underground on September 10, 1965, at the Nevada Test Site was reported to have been in the low-intermediate yield range.

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
BeV	billion electron volts	see GeV
Ci	curie	3.7×10^{10} dps
cm	centimeter(s)	0.394 inch
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	
GeV	giga electron volts	1.6×10^{-3} ergs
kg	kilogram(s)	1000 g = 2.205 lb
km²	square kilometer(s)	
kVp	kilovolt peak	
m³	cubic meter(s)	
mA	milliampere(s)	
mCi/m²	millicuries per square mile	0.386 nCi per square meter (mCi/km²)
MeV	million (mega) electron volts	1.6×10^{-6} ergs
mg	milligram(s)	
mi²	square mile(s)	
ml	milliliter(s)	
mm	millimeter(s)	
nCi/m²	nanocuries per square meter	2.59 mCi per square mile
pCi	picocurie(s)	10^{-12} curie = 2.22 dpm
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs per gram

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr' a
10^{9}	giga	G	jĭ' ga
10^{6}	mega	M	mĕg' a
10^{3}	kilo	k	kĭl' o
10^{2}	hecto	h	hĕk' to
10	deka	da	dĕk' a
10^{-1}	deci	d	dĕs' ĭ
10^{-2}	centi	c	sĕn' tĭ
10^{-3}	milli	m	mĭl' ĭ
10^{-6}	micro	μ	mī' kro
10^{-9}	nano	n	năn' o
10^{-12}	pico	p	pē' co
10^{-15}	femto	f	fĕm' to

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